

Fundação para a Ciência e a Tecnologia

Evaluation Research Unit 2013

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1. IDENTIFICATION OF THE R&D UNIT

1.0 Reference

50022

1.1 Name of the R&D Unit

Associate Laboratory of Energy, Transports and Aeronautics

1.2 Acronym

LAETA

1.3 Coordinator

José Carlos Fernandes Pereira

1.4 Multidisciplinary/interdisciplinary R&D Unit

No

Scientific areas

Mechanical Engineering and Engineering Systems(**Main Scientific Area**)

1.5 Profile of the R&D Unit

20% Basic research

80% Applied research and/or Experimental development

1.6 Keywords

Mechanical Engineering

Aerospace Engineering

Transports Technology

Energy

1.7 Link to the R&D Unit's page on the Internet

<http://www.idmec.ist.utl.pt/laeta/>

1.8 Unit registration options

Keep

2. INSTITUTIONS AND THEIR ROLES

2.1 Main Host Institution

Instituto de Engenharia Mecânica (IDMEC)

2.2 Other(s) Host Institution(s)

Associação para o Desenvolvimento da Aerodinâmica Industrial (ADAI)

Universidade da Beira Interior (UBI)

Instituto de Engenharia Mecânica e Gestão Industrial (INEGI/UP)

2.3 Participating Institution(s)

Institution Name Host Institution

2.4 Institutional commitment

The participating Institutions in this proposal are:

- the Institute of Mechanical Engineering (IDMEC) of Instituto Superior Técnico at the University of Lisbon (UL)
- the Institute of Engineering and Industrial Management (INEGI) at the University of Porto (UP)
- the Association for the Development of Industrial Aerodynamics (ADAI) at the University of Coimbra (UC) and
- the Aeronautics and Astronautics Research Group (AEROG) at the University of Beira Interior (UBI)

LAETA is organized as an Associate Laboratory of 4 research institutions (IDMEC, INEGI, ADAI and AEROG), which are recognized by the FCT in the fields of energy, transport technologies, aeronautics and key-enable mechanical engineering technologies

IDMEC is a non-profit research and development private association and created in 1992, located at Instituto Superior Técnico, University of Lisbon with 107 PhD researchers that promotes the interface between the mechanical engineering department, national and international funding agencies and industry. IDMEC has been involved in several European Union (BRITE-EURAM, SMT, GROWTH, NMP, Aeronautics, Transports, etc.) and EUREKA projects

INEGI is a non-profit research and development private association and created in 1986, located at Faculdade de Engenharia do Porto, University of Porto with 116 PhD researchers that promotes the interface between the mechanical engineering department, national and international funding agencies and industry. INEGI has been playing a significant role in the development of the Portuguese industry during its 27 years of existence and has been involved in several European Union projects

ADAI is a non-profit research and development private association and created in 1990, located at Faculdade de Ciências e Tecnologia, University of Coimbra with 22 PhD researchers that promotes the interface between the mechanical engineering department national and international funding agencies and industry, in the fields of energy, fires and detonics. ADAI has also been involved in several European Union projects

AEROG is a research institution of the University of Beira Interior (UBI) with 8 PhD researchers that promotes the interface between the mechanical engineering department, national and international funding agencies and industry, in the field of aeronautics. UBI was founded in 1986 and is a stakeholder of the Technological Park of Covilhã, where spinoff university companies contribute for leveraging and diversifying the local economy

The participating Institutions, IDMEC/UL, INEGI/UP, ADAI/UC and AEROG/UBI declare their willingness to take part in the efficient implementation of the project and that they will cooperate in performing and fulfilling - promptly and within established deadlines - all their contractual obligations whilst providing the human, financial and technical resources (space, equipment and materials) required to effectively carry out the programme as defined in this proposal.

3. R&D UNIT DESCRIPTION AND ACHIEVEMENTS

3.1 Description of the R&D Unit

Structure

LAETA is an Associate Laboratory with 253 PhD holders - accounting for more than 1 300 research papers in international journals over the last five years - affiliated to 4 Research Units from four Universities. The Research Units are: the Institute of Mechanical Engineering (IDMEC) of Instituto Superior Técnico at the University of Lisbon (UL), the Institute of Mechanical Engineering and Industrial Management (INEGI) at the University of Porto (UP), the Association

for the Development of Industrial Aerodynamics (ADAI) at the University of Coimbra (UC) and the Aeronautics and Astronautics Research Group (AEROG) at the University of Beira Interior (UBI)

The groups are located in 3 Portuguese Regions, (NUT-II): there are 5 Research Groups in the region of Lisbon and the Tagus Valley Region; there are 2 groups in the North Region and 3 groups located in the Central Region. Each of these groups pursues a particular specialisation in relation to the major objectives outlined above

At the same time, LAETA is organized around 5 Thematic Research Lines - in line with the main objectives - and 10 Research Groups. The Laboratory is organised into a matrix in which the Thematic Research Lines correspond to the rows and the Research Groups correspond to the columns. The Research Lines are Energy, Transport Technologies, Aeronautics and Space, Key Enable Technologies and Future Emerging Technologies

The Key Enable Technologies (Advanced Manufacturing, Advanced Materials, Biomechanics, Fires, Engineering Design and Engineering Systems) provide the fundamental scientific knowledge required in furthering research in the fields of Energy, Transports and Aeronautics and a large number of applications in the field of Mechanical Engineering. In addition, the Future Emerging Technologies line will foster the development of new ideas and encourage long term research.

Added Value

The laboratory has significantly contributed to unifying the areas of Energy, Transports and Aeronautics as well as Key Enable Technologies. LAETA possesses three central qualities: excellence, critical mass and the ability to cover all fields in the Energy, Transport technologies and Aeronautics sectors. The laboratory is able to achieve this in a multidisciplinary and holistic fashion

Similarly, LAETA's dimension and critical mass allows the laboratory to deploy its expertise across the main fields of non-nuclear energy (with the exception of electrical grids) as well as in the domains of Transport technologies and the core areas in Aeronautics and Space. As described below, LAETA covers the area of Key Enable Technologies from a transversal perspective that contributes to the advancement of Energy, Transports and Aerospace

Moreover, LAETA engineering know-how is actively involved in the fields of energy, transport technologies and aeronautics. In particular, the laboratory is involved in:

- furthering excellence in research and technology concept formulation
- enabling technological development in the laboratory and industrial environments
- transferring technologies to society at large with a view to implementing new engineering procedures related to the project stage, design, manufacturing and testing of products for public and private institutions
- promoting partnerships with SME's, European consortia, national and international entities involved in regulation and standardisation
- promoting the dissemination of knowledge and the education and training of technicians and engineers in order to overcome existing lacks in education and so as to acquire new competences
- contributing to the regional innovation plan

Research Groups

The objectives of the Thematic Research Lines are pursued by 10 Research Groups each possessing a high degree of expertise

Aerospace Science & Technology Group-1 Prof L B Campos

Integration in aeroacoustics, flight dynamics, simulation and control, multidisciplinary design optimization, morphing structures, flight testing, air traffic management, space science and mission planning

Intelligent Systems Group -2 Prof J M Sousa

To foster the interplay of systems and control theory and engineering applications: mechatronic systems, network distributed systems, intelligent data modelling and optimization, and systems engineering in the life sciences

Manufacturing and Industrial Management Group-3 Prof P Martins

Mechanical processing of materials and thermal processing of materials; polymer and ceramic material processing; lean, agile and life cycle approaches to manufacturing

Mechanical Design Group - 4 Prof H Rodrigues

Computational and experimental mechanics: Simulation and Design of Mechanical Systems and Components; Modelling and Optimization of Structures and Materials; Structural Materials and Advanced Characterization

Renewable and Sustainable Energy Group-5 Prof M Costa

Turbulence, computational fluid dynamics, and experimental fluid mechanics; efficiency, renewable energy, hydrogen and fuel cells; clean combustion and energy and environment in transports and turbomachinery

Experimental Mechanics and New Materials Group -6 Prof M Vaz

Composite Materials; Tribology, Vibrations & Industrial Maintenance; Experimental Mechanics and Non-destructive testing; Manufacturing Processes

Engineering Design, Automation and Energy Group-7 Prof A Fernandes

Development of efficient computational mechanics tools for metallic and composite structures, damage mechanisms and failure criteria for advanced composites and metallic structures; control engineering, real-time communications, advanced transducers for bio-engineering/health and industrial applications; developing tools and techniques for new manufacturing and process control applications and remote and virtual training systems; energy in the built environment, advancing methods for energy efficient buildings and cities, and for indoor air quality

Energy, Environment and Comfort Group-8 Prof M Silva

Computational or experimental methods in energy efficiency, environmental assessment and management, indoor environmental quality, wind engineering, industrial aerodynamics and industrial ecology

Forest Fires and Detonics Group-9 Prof D X Viegas

Fundamental and applied research into forest fires, namely on meteorological factors, fuels, fire spread and fire safety;

industrial and urban fires, energetic materials, pyrotechnics, detonation and non-lethal weapons
Aeronautics and Astronautics Group-10 Prof K Bousson
Flight mechanics, satellites, experimental fluid mechanics, and morphing technologies

Management

The LAETA Scientific Council is composed of the members of Executive Council, the coordinators of Research Groups, the Coordinators of Research Lines and Strands, and three experts from industry. The Coordinators of the Research Groups are members of the Scientific Council and provide the technical and scientific input that will ensure that LAETA meets all the various scientific objectives that have been set

3.2 Major achievements

In the last five years, LAETA has been involved in exploring new sources of renewable energy; improving the energy efficiency of mechanical systems; the development of resource efficient, environmental friendly and safe transport systems and developing new tools for medical diagnostics and treatment alongside devising new ways to create a cleaner and healthier environment. In addition, a number of cutting edge technologies for concept development, detail design and manufacturing have been investigated and applied to the development of new products, new processes and to the improvement of existing products and processes. Modelling, simulation and experimentation have been extensively utilised in the majority of these developments and improvements

The main results representing the specific strengths of Groups that are of critical importance in terms of strategic direction are, briefly, as follows:

Energy

- New physical insight into the turbulent entrainment obtained by DNS of turbulent jet flows and new LES models and their Best Practice Advice to allow better predictions of turbulent combustion flows
- New exposure studies in association with public health R&D structures and other medical specialists addressing special critical indoor environments such as schools
- Design and thermal optimization of a CHP for tri-generative use (power/heating/cooling) at building level by advanced 3D fluid heat and reaction modelling
- Geometry optimization and model testing of a new patented geometry for spar-buoy OWS wave energy converter; non-linear modelling of moorings for arrays of floating wave energy converters

Transport Technologies

- Development of models and applications in crashworthiness and impact, biomechanics of motion, vehicle dynamics, railway dynamics and accident reconstruction
- Development of a new concept of intercooler for automotive industry
- Development and implementation of a new fleet of generic road vehicle models for passive safety studies, with DRFiat, Daimler-Crysler and Renault
- Design, development and implementation of filament winding strategies for composite overwrap pressure vessels (industrialization by Amtrol Alfa)

Aeronautics and Space

- Experimental and numerical characterization of the upstream part of a ground vortex resulting from the collision of a ground vortex with a crossflow with relevance for a VSTOL aircraft
- Criteria for modelling damage and failure for advanced composites and metallic structures through collaboration with ESA, NASA, the US Air Force and Airbus.
- Development of a new manufacturing process for producing metallic liners for composite overwrapped pressure vessels (COPV's) that are commonly utilized in spacecraft (subcontracted by ESA)
- New structural concepts for morphing wings for the aerospace industry in collaboration with EMBRAER
- UAV's design, test and production in collaboration with Portuguese Airforce.
- Development of a demonstrator of an aircraft cabin concept (awarded the "Crystal Cabin Award", in 2012) in collaboration with 4 Portuguese industrial companies and Embraer (Brazil)

Key Enable Technologies

Advanced Manufacturing

- Development of an innovative and environmental friendly tube joining process based on asymmetric plastic instability that can be successfully utilized to fix tubes to tubes and tubes to sheets made from dissimilar materials
- Design, fabrication and instrumentation of an electromagnetic cam driven compression testing machine for testing materials under high rates of loading
- Optimal design of adhesive bonded joints of metallic and composites structures and multi-materials joints
- Development of a casting process for impellers applied in turbocompressor using low pressure and vacuum, with aluminium super alloys and titanium aluminides
- Development and implementation of filament winding strategies for composite overwrap pressure vessels

Advanced Materials

- Optimization of the GC/FID method for on-line quantification of the selected compounds that are the object of

photocatalytic degradation

- Development, modelling and characterization of thin-ply composites
- Multiscale computational modelling of advanced composite materials and structures
- Development of micro mechanical model for piezoelectric materials microstructure optimization
- Development of materials for the first European carbon fibre pre-preg for space applications.

Biomechanics

- Microfluidic experimental techniques (PIV, pressure sensors, viscosimeter) to characterize steady and unsteady rotating and non-rotating blood flows inside microdevices
- Pattern recognition and neural networks for application in medical imaging to support the training of new doctors as well as for aid in diagnosis
- Development of an active ankle-foot orthosis with a hybrid actuation solution to support individuals with locomotion pathologies such as drop foot
- Development of computation models for the normal and pathological shoulder and reverse shoulder prosthesis

Fires

- Analysis of dynamic behaviour of forest fires in canyons. Modelling spot fires and extreme fire behaviour conditions associated to fire safety related problems
- Analysis of large forest fires and fatal accidents in Portugal, Israel and Spain
- Explosive-based technologies applied to manufacturing processes
- Analysis of fire, smoke and toxicity of materials
- Research for improvement of flammability with carbon nanotubes and nanoclays

Engineering Design

- Structural integrity analysis, fatigue and fracture materials behavior of components for various engineering applications under uniaxial and biaxial constant and variable amplitude loading
- Materials selection considering technical performance, process cost and life cycle evaluation
- Development of failure criteria for FRP laminates LaRC (selected for ESACOMP and implemented in Hypersizer22 software)
- Project and design of composite overwrap mid pressure vessels (400 bar)
- Development of the composite concepts for the interior and aircraft fuselage and in building many of the components for the 8m long demonstrator

Engineering Systems

- Development and application of new methodologies for distributed intelligent optimization of complex systems (modelling, control and optimization of networked systems, supply chain systems, logistic processes)
- Development of robotic devices for manipulation and locomotion, with special applications in surgical robotics and exoskeletons
- Development of new techniques for hip-resurfacing surgical procedures, and active ankle-foot orthotics to correct drop-foot pathologies in exoskeletons.
- Development of instrumentation for mechatronic systems.

Key Publications

- R. Martins, R. Amaro and J. Seabra, "Influence of low friction coatings on the scuffing load capacity and efficiency of gears". *Tribology International*, Vol. 41/4 (2008), pp. 234-243, doi:10.1016/j.triboint.2007.05.008
- P. Maimí, P.P. Camanho e J.A. Mayugo, A three-dimensional damage model for transversely isotropic composite laminates, *Journal of Composite Materials*, Vol. 42, 2717-2745, 2008. doi: 10.1177/0021998308094965
- A.M.A. Neves, A.J.M. Ferreira, E. Carrera, M. Cinefra, C.M.C. Roque, R.M.N. Jorge, C.M.M. Soares, A quasi-3D hyperbolic shear deformation theory for the static and free vibration analysis of functionally graded plates *Composite Structures*, Volume 94, Issue 5, April 2012, Pages 1814-182 , doi:10.1016/j.compstruct.2011.12.005
- da Silva, Carlos B.; dos Reis, Ricardo J. N.; Pereira, Jose C. F., 2011, The intense vorticity structures near the turbulent/non-turbulent interface in a jet , *Journal of Fluid Mechanics* Volume: 685 Pages: 165-190, DOI: 10.1017/jfm.2011.296
- Viegas D.X., Raposo J.R., Davim D., Rossa C.G., 2012. Study of the Jump Fire Produced by the Interaction of Two Oblique Fire Fronts. Part 1: Analytical Model and Validation with No-slope Laboratory Experiments. *International Journal of Wildland Fire* 21, 843-856. , Doi:10.1071/WF10155
- Mendonça, L. F.; Sousa, J. M. C.; Sá da Costa, J. M. G., "An architecture for fault detection and isolation based on fuzzy methods". *Expert Systems With Applications*, 36(2): 1092-1104, March 2009, DOI: 10.1016/j.eswa.2007.11.009
- Z Ma, JMRS Tavares, RM Natal Jorge, T Mascarenhas, "A review of algorithms for medical image segmentation and their applications to the pelvic cavity", *Computer Methods in Biomechanics and Biomedical Engineering*, 13:235-246, 2010, DOI:10.1080/10255840903131878
- Pombo, Joao; Ambrosio, Jorge, Multiple Pantograph Interaction With Catenaries in High-Speed Trains , *JOURNAL OF COMPUTATIONAL AND NONLINEAR DYNAMICS* Volume: 7 Issue: 4 Article Number: 041008, 2012, DOI: 10.1115/1.4006734
- L.M.B.C. Campos "On an analytical model of the aerothermodynamics of fluid-structure interaction", *Acta*

Astronautica, volume 64, pages 971-978. (2009), DOI: 10.1016/j.actaastro.2008.12.003

• Falcao, L; Gomes, AA ; Suleman, A, Aero-structural Design Optimization of a Morphing Wingtip, JOURNAL OF INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES , vol 22, P. 1113- 1124, 2011
DOI:10.1177/1045389X11417652

3.3 External Advisory Committee Reports

R&D Unit File

LAETA [External Advisory Committee Reports.pdf](#)

3.4 Composition of the External Advisory Committee

R&D Unit Member Name	Institution
LAETA Junuthula N. Reddy	Texas A&M University - USA
LAETA Prof. A. Erman Tekkaya	Technical University Dortmund, Germany
LAETA Prof. Shaker Meguid	University of Toronto - Canada
LAETA Prof. Roman Weber	Technical University Clausthal, Germany
LAETA Prof. Ole Sigmund	Technical University of Denmark
LAETA Prof. Frank L. Lewis	University of Texas at Arlington

3.5 Brief description of the output indicators 2008/2012 of the research team of the new unit that support the vision and objectives of the strategic program

4. FUNDING 2008/2012

4.1

Description	2008	2009	2010	2011	2012	TOTAL (€)
Pluriannual Programme/Strategic project	1905400	2166251	2197944	2295000	1984125	10548720
FCT-funded projects	1100596	1715347	2762176	2165000	2670850	10413969
European Commission-funded projects	1496577	2009434	1147897	831000	1464966	6949874
Other international projects	580000	760000	440000	320000	579173	2679173
Other national projects	1288013	1679370	1677229	1522000	2269563	8436175
National industry projects	1824771	3587481	1757756	1499000	3558517	12227525
International industry projects	194875	308629	274527	308000	588689	1674720
TOTAL (€)	8390232	12226512	10257529	8940000	13115883	52930156

5. GENERAL INDICATORS 2008/2012

5.1

Description	2008	2009	2010	2011	2012	TOTAL ()
No. of researchers	461	480	516	479	495	2431
No. of integrated researchers	225	230	232	240	230	1157
No. of technicians and administrative staff	25	26	29	30	30	140
PhD theses under the supervision of integrated members	26	21	29	30	37	143

Publications in international peer reviewed journals	258	312	292	297	232	1391
Books and chapters of international distribution	30	31	24	31	20	136
Models	5	7	4	5	6	27
Patents	21	13	10	5	5	54
Prototypes	12	20	14	18	15	79
Industry research contracts	96	89	68	63	64	380
Research contracts with national or international bodies	190	142	179	204	120	835

5.2 Overall description of indicators and research outputs/Highlights

The scientific quality of the researchers from LAETA guarantees outstanding research capabilities.

The track record of the team members of LAETA in the past five years includes, approximately, the publication of 1400 research papers in international scientific journals with peer reviewing, 2 900 research papers in international conferences, 136 books and chapters in books

The number of M.Sc. and Ph.D. theses completed in the last five years was equal to, respectively, 1 000 and 130.

LAETA also has a significant experience in promoting international conferences, symposia and workshops (200).

LAETA in conjunction with major scientific societies has organised a number of extremely large-scale international scientific conferences including about 25% of ECCOMAS conferences (ECCOMAS and ECCOMAS Thematic Conferences), and IUTAM, EUROMECH, Biomechanics European Society, Composites, etc.)

The annual indicators on research output are:

Ratio of papers in International Journals (ISI)/ Faculty member =2.1

Ratio of papers in International Journals (ISI)/ Integrated researcher =1.4

Ratio Ph.D. Degrees/Faculty member=0.21

Ratio Ph.D. Degrees/ Integrated researcher = 0.16

Ratio M.Sc. Degrees/ Faculty member =1.3

The papers published have all appeared in ISI international journals. The LAETA has 11% publications in the top 10% of the world. Also 23% of the papers have been published in collaboration with international researchers from 40 Countries, namely USA, Brasil, England, Spain and Canada. The annual ratio of papers in International Journals (ISI)/ Integrated researcher equal to 1.4 is far higher than the national average in engineering publications (0.5). LAETA scientific production represents about 2% of the national production in all fields of R&D. The number of Ph.D. thesis also corresponds to 2% of the national average.

LAETA staff has registered 54 patents over the last 5 years and a large number of LAETA staff has participated in major international scientific societies and/or are members of the executive committees and/or are Horary Fellows of ECCOMAS, IUTAM, EUROMECH, the European Biomechanics Society, Composites Society, ISSMO (International Society for Structures and Multidisciplinary Optimization).

Mota Soares is Honorary Fellow of IACM (22 Honorary Fellows of 20000 members); Fellow ECCOMAS; 2009 Distinguished Person by the Ibero-American Federation of Mechanical Engineering; National Delegate to NMP program of UE; President of Portuguese Association of Theoretical, Applied and Computational Mechanics

Antonio Fernandes is National Delegate to the EU NMP; Member of Panel of the EU Research Fund for Coal and Steel; 2011 Distinguished Person by the Ibero-American Federation of Mechanical Engineering

Prof. M. Seabra Pereira is National Delegate to Transport Program UE and Vice-Chairman of the Technological Platform ERRAC - The European Rail Research Advisory Council

H. Rodrigues is General Secretary of ISSMO, member of Academy of Science

J.C. Pereira, member of ACARE (Advisory Council for Aviation Research and Innovation in Europe)

Silva Gomes, National Delegate to UE Aeronautic program

Cesar Sá is member of Academy of Science

Maria da Graça Carvalho former Minister of Science and Higher Education of the Government of Portugal, former President of the Portuguese Association of Engineers. She is a member of 22 national and international scientific associations and fellow of AIAA, of AAAS-American Association for the Advancement of Science, of the WAAS - World Academy of Art and Science and of the Portuguese Academy of Science. She is member of the European Parliament since 2009 (member of the ITRE-Industry, Research and Energy Committee). She has been Principal Adviser of President Barroso of UE in the areas of Science, Higher Education, Innovation, Research Policy, Energy, Environment and Climate Change from 2006 to 2009

Five LAETA Researchers are Editors-in Chief of international Journals

J. Ambrósio, Multibody Systems Dynamics, Springer, (IF=2.023) (Q1-ISI)

A. Ferreira, Composite Structures, Elsevier, (IF=2.550) (Q1-ISI)

L. F. M da Silva, Journal of Adhesion, Taylor & Francis, (IF=1.003) (Q3 - ISI)

J. Pombo, Int. Journal of Railway Technology, Saxe-Coburg Publications (recent)

R. Natal Jorge, Journal for Computational Vision and Biomechanics (recent)

LAETA researchers have been the Guest-Editor of more than 50 special issues organised by international journals.

LAETA Researchers are Editors of 3 International Springer Book Series: L. da Silva for Briefs in Engineering Computational Mechanics and Advanced Structured Materials, and R. Natal Jorge in Computational Vision and Biomechanics, and Lecture Notes in Computational Vision and Biomechanics. A large number of LAETA researchers are members of scientific editorial teams on 115 International journals and reviewers for more than 300 International journals.

In the last five years, LAETA was ranked 1st place among all associated laboratories in Portugal in terms of the level of competitive funding raised from European projects, national projects, consultancy and services compared with strategic funding obtained from the FCT. LAETA has been able to raise € 6.36 per euro of strategic funding from FCT. Over the last five years, LAETA has attracted €5.2 M of competitive funding from the European Seventh Framework Program (FP7) and has been ranked in 8th place among all research units in Portugal regarding European funding secured over the last five years.

Finally, over the same period, 17 Company Spin Offs have been created by LAETA researchers.

In a report by FCT, for the period 2007-2011, LAETA is the 7th (2nd in Engineering) national research institution with more research papers (1146) published in ISI Journals.

6. SCIENTIFIC COMPONENT - STRATEGIC PROGRAMME 2015/2020

6.1 Abstract in Portuguese for publication

O Laboratório Associado de Energia, Transportes e Aeronáutica, LAETA, tem 253 Doutorados e é filiado a quatro Unidades de Investigação de quatro Universidades. As Unidades de Investigação são: o Instituto de Engenharia Mecânica (IDMEC) da Universidade de Lisboa (UL); o Instituto de Engenharia Mecânica e Gestão Industrial (INEGI) da Universidade do Porto (UP); a Associação para o Desenvolvimento da Aerodinâmica Industrial (ADAI) da Universidade de Coimbra (UC); e o Grupo de Investigação Aeronáutica e Astronáutica (AeroG) da Universidade da Beira Interior (UBI). Paralelamente, o LAETA está organizado em 5 Linhas Temáticas de Ação - de acordo com os objetivos principais - e em 10 Grupos de Investigação. O Laboratório está organizado numa matriz onde as Linhas Temáticas de Ação correspondem às linhas e os Grupos de Investigação correspondem às colunas. As Linhas de Ação são: Energia; Tecnologia dos Transportes; Aeronáutica; Tecnologias Fundamentais Facilitadoras; e Tecnologias Futuras Emergentes. O LAETA é composto por 10 grupos de investigação e desenvolvimento que têm uma longa experiência na investigação e desenvolvimento das principais questões associadas a avanços existentes e previsíveis nas áreas da energia, dos transportes e da aeronáutica

Atualmente assiste-se a uma mudança de paradigmas entre combustíveis fósseis e sistemas centralizados para formas amigáveis de energia e formas descentralizadas de capturar energias renováveis e convertê-las em energia final útil. Os três vetores básicos da política energética são a segurança do abastecimento, o respeito pelo ambiente e os custos competitivos. Do ponto de vista do fornecimento, surge um amplo espectro de tópicos de investigação: fontes de energia a preços acessíveis; confiança na conversão de energia e sistemas de gestão; processos sustentáveis para a utilização de combustíveis convencionais; análise sistémica de risco de incêndio; etc. Conceitos como eficiência energética ou, num contexto mais abrangente, como ambiente urbano sustentável, aproximando-se da energia e do meio ambiente pelo lado da procura, são também muito interessantes em termos de oportunidades e desafios de novas tecnologias, novos métodos e processos de como usar a energia

O transporte e a mobilidade são a força vital da economia Europeia, tornando-se fatores indispensáveis para um crescimento competitivo e sustentável da Europa. Mais de 90% das transferências de bens e passageiros na Europa são feitas por meios de transporte de superfície. As exigências de energia mais eficiente e mais limpa para o transporte, bem como para o uso urbano e industrial, desempenham um papel fundamental na equação do desenvolvimento sustentável e, em conjunto com as estratégias de desenvolvimento dos transportes, fazem parte das estratégias Nacionais e Europeias estabelecidas em diferentes livros brancos, protocolos e contratos. Com o desenvolvimento dessas tecnologias surgem sinergias com outras aplicações, tais como aplicações aeroespaciais, as quais estão também associadas ao LAETA

A Aeronáutica e o Espaço estão a entrar numa nova era - a era do crescimento sustentável -, caracterizada pela necessidade de transportes aéreos e explorações espaciais de maiores acessibilidades financeiras, mais limpos, mais silenciosos e mais seguros. Novas formas de investigação e desenvolvimento são essenciais para responder a este desafio. A missão consiste em desenvolver ciência da engenharia fundamental e tecnologias associadas com aplicação aos veículos aéreos e espaciais, sistemas associados e componentes. O programa do trabalho de investigação está previsto em conformidade com o objetivo de fortalecer e integrar as iniciativas de investigação nacionais e europeias e responder às necessidades da sociedade por viagens aéreas e explorações espaciais mais eficientes, mais seguras e amigas do ambiente

As Tecnologias Fundamentais Facilitadoras compreendem a Manufatura Avançada, a Engenharia de Design; a Engenharia de Sistemas; os Fogos e Detónica; os Materiais Avançados; e a Biomecânica. Estas especializações apoiam as três áreas acima mencionadas (Energia, Tecnologias de Transporte e Aeronáutica) e são capazes de gerar novos conhecimentos de valor acrescentado, os quais podem posteriormente ser incorporados em sistemas mais complexos. As Tecnologias Futuras Emergentes permitem o aparecimento de novas ideias e suportarão áreas emergentes que ainda não estão aptas a serem incluídas nos roteiros de investigação da indústria

A missão do LAETA é coordenar investigação básica e aplicada e realizar transferência de tecnologia para a economia e para a sociedade em geral, em áreas selecionadas de Tecnologias de Transporte e Energia e Aeronáutica, bem como contribuir para a formação avançada em engenharia mecânica, enquanto o desenvolvimento económico de Portugal e, em particular, das três regiões onde os Grupos de Investigação estão localizados se encontra em linha com os objetivos europeus propostos do Horizonte 2020

O objetivo geral do LAETA é aplicar I&D para suportar a implementação simultânea do modelo de três pilares ao longo de uma cadeia de inovação, partindo da investigação básica, passando pela investigação tecnológica até ao desenvolvimento de produtos e prototipagem

Os objetivos do LAETA serão focados na Investigação, para estimular o conhecimento científico com o intuito de adquirir novas competências, e no desenvolvimento, para promover a disseminação do conhecimento ao nível da pós-graduação, incluindo programas doutorais e de formação avançada. O laboratório também pretende promover parcerias com instituições públicas e privadas, consórcios europeus com PMEs, entidades nacionais e internacionais envolvidas na regulamentação, normalização e I&D

A massa crítica alcançada pelos 253 Doutorados e pela sua multidisciplinaridade vai garantir contribuições de grande valor para uma indústria mais competitiva e avanços na investigação de ponta nas áreas abrangidas pelo LAETA

6.2 Abstract in English for evaluation

The Associate Laboratory of Energy, Transports and Aeronautics, LAETA, has 253 PhD holders and is affiliated to 4 Research Units from four Universities. The Research Units are: the Institute of Mechanical Engineering (IDMEC) at the University of Lisbon (UL), the Institute of Mechanical Engineering and Industrial Management (INEGI) at the University of Porto (UP), the Association for the Development of Industrial Aerodynamics (ADAI) at the University of Coimbra (UC) and the Aeronautics and Astronautics Research Group (AEROG) at the University of Beira Interior (UBI). At the same time, LAETA is organized around 5 Thematic Research Lines - in line with its main objectives - and 10 Research Groups. The Laboratory is organised into a matrix in which the Thematic Research Lines correspond to the rows and the Research Groups correspond to the columns. The Research Lines are Energy, Transports Technology, Aeronautics and Space, Key Enable Technologies and Future Emerging Technologies. LAETA is composed of 10 groups of research and development that possess long standing experience in the research and development of the major issues associated with existing and foreseeable breakthroughs in the areas of energy, transports, and aeronautics.

Energy is a critical issue nowadays as we undergo a paradigm shift from fossil fuels and centralized systems towards energy friendly forms and decentralized manners of capturing renewables and converting primary into final/useful energy forms. The three basic vectors of every energy policy - security of supply; environmental friendliness and competitive costs - involve a wide spectrum of research topics: affordable energy sources; reliable energy conversion and managing systems; sustainable processes for the utilization of conventional fuels; systemic risk analysis related to fire; concepts such as energy efficiency, or in a more comprehensive context, such as sustainable urban environments. Approaching energy and environment from the demand side, there is also a large range of rich opportunities and challenges for new technologies, new methods and processes on how best to use energy.

Transport and mobility are the lifeblood of the European economy and represent two crucial factors in fostering competitive and sustainable growth in Europe. Over 90% of all goods and passenger transfers within Europe are made by surface transport modes. The demand for more efficient and cleaner energy for transport as well as for urban and industrial use plays a crucial role in sustainable development. Together with strategies for transport development, this demand is central to the National and European strategies established in various white papers protocols and contracts. The development of these technologies will give rise to new synergies with other applications - such as aerospace - associated with LAETA.

Aeronautics and Space are entering a new age - the age of sustainable growth - characterized by the need for more affordable, cleaner, quieter, safer air travel and space exploration. New research and development will be essential in responding to this challenge. The mission consists of developing fundamental engineering science and associated technologies with application to air and space vehicles, associated systems and components. The research work programme has been planned with a view to strengthening and integrating national and European research initiatives and meeting society's needs for more efficient, safer and environmentally friendly air travel and space exploration. The Key Enable Technologies comprise Advanced Manufacturing, Engineering Design; Engineering Systems; Fires and Detonics; Advanced Materials, Biomechanics. These specialisations support the three main focus areas of the laboratory (Energy, Transport Technologies including Aeronautics) and are able to generate new knowledge of greater added value. This can subsequently be embedded into more complex systems. Future enable technologies will allow for the emergence of new ideas and will support emerging areas that are not yet ready for inclusion in existing industry research roadmaps.

LAETA's mission is to conduct basic and applied research and perform transfer of technology to the economy and to society at large in selected areas of Energy, Transport Technologies and Aeronautics and to contribute to advanced education in mechanical engineering. This will foster the economic development of Portugal and, in particular, of the three regions where the Research Groups are located (in line with Europe 2020 Horizon objectives).

The general objective of LAETA is to apply R&D that supports the simultaneous implementation of the three-pillar bridge model along the innovation chain, from basic research, through technological research up to product development and prototyping.

LAETA's objectives will be focused on research to improve scientific knowledge (with the goal of acquiring new

competences) and on development (with the aim of promoting the dissemination of knowledge at post-graduate education, including PhD programs and advanced training). The laboratory also intends to promote partnerships with public and private institutions, SME's European consortia, National and international entities involved in regulation, standardization and R&D (orientated towards the provision of services). The critical mass achieved by 253 Ph.D. holders and the multidisciplinary that this entails will ensure valuable contributions to furthering industrial competitiveness and breakthroughs in frontier research in the areas covered by LAETA

6.3 Strategy and vision of the unit and future management

Mission and Vision

LAETA's mission is to conduct basic and applied research in selected areas of Energy, Transport Technologies and Aeronautics and to contribute to advanced education in mechanical engineering whilst furthering the economic development of Portugal and in particular the three regions where the Research Groups are located in line with Europe 2020 Horizon objectives

LAETA's vision is to situate itself amongst the most renowned international mechanical engineering research centres in its different areas of specialisation. These areas of specialisation are selected topics within Energy, Transport Technologies including Aeronautics and Key Enable Technologies (comprising Advanced Manufacturing, Engineering Design; Engineering Systems; Fires and Detonics; Advanced Materials, Biomechanics). These specialisations support the above three areas (Energy, Transport Technologies including Aeronautics) and are able to generate new knowledge of greater added value that can subsequently be embedded into more complex systems. It is expected that these subsequent applications will drive major economic growth and competitiveness. Furthermore LAETA is dedicated to striking a balance between bottom-up and top-down research as this allows for risk taking when developing innovative ideas and projects (Future and Emerging Technologies)

R&D to be performed by LAETA

LAETA based research contributes to finding solutions to the major challenges faced by contemporary society and which represent priorities of the first order at European, National and Regional scale. These include clean accessible and affordable energy and clean and safe transport, (including aeronautics)

- The Energy challenges that LAETA seeks to meet include the transition to a reliable, affordable, publicly accepted, sustainable and competitive system, one that aims to reduce fossil fuel dependency in the face of increasingly scarce resources and to fight climate change. The work undertaken by LAETA contributes to the implementation of European energy and climate change policy and its application in Portugal
- Transports, including Aeronautics, are high priorities on the European agenda and, in this respect, a European transport system that is resource efficient, climate and environmentally friendly, safe and seamless is required. This will have both economic and social benefits
- Key enable technologies will have the dual objective of, firstly, providing engineering know-how to Energy, Aeronautics and Transports in areas not directly covered by the researchers working in these fields and, secondly, of contributing to the reindustrialization objectives of national and European economies. The first objective is necessary to help transform ideas into concrete, high-value products whereas the second objective is necessary to upgrade the technological level of existing industrial companies and to attract new industrial investment
- In addition, the Future emerging technologies will allow for the emergence of new ideas and will support a large set of early stage, highly interdisciplinary research approaches in Energy, Transports and Aeronautics and other related areas within the field of Mechanical Engineering. The main benefits are new, emerging areas that are not yet mature enough for inclusion in industry research roadmaps

LAETA also comprises a regional dimension contributing to smart specialization and to the regional development of the regions where the Research Groups are located

The strategy that will be adopted in order to bring LAETA's vision to fruition involves the promotion of excellent research, Post-Graduate education and the laboratory's ability to cover the whole cycle of innovation from research to technological development, pilot scale, industrial demonstration and early entrance to the market. LAETA strategy towards innovation involves 1) ensuring the adequacy and renewal of human resources, 2) promoting the creation of high-quality knowledge and competence in Portugal and the efficient transfer of knowledge created elsewhere for our own use and 3) accelerating the exploitation of knowledge and expertise

The R&D to be performed is fundamentally orientated towards the first stage in deploying scientific excellence in such a manner as to allow ideas arising from fundamental research to become operating technologies. This should be achieved by means of proofs of concept and be proprietary, that is to say, protected by patents

Following from this stage, the second stage deploys the Key Enable Technologies competences and facilities for project, design, instrumentation, control and manufacturing. The goal is to enable the production of functional prototypes as well as the manufacture of low batch series of innovative high-valued products or the application of innovative systems and solutions to prototypes and products. The participation in national and European projects allows the laboratory to establish prototype/product validation in terms of user performance by demonstration and deployment operations at appropriate scale

Management structure

The management of LAETA will be undertaken by the Executive Council of LAETA, which coordinates the activities

promoted by the Scientific Council and the recommendations of the Advisory Council. The Executive Council is composed by the President and Scientific Coordinator of LAETA, Prof J C Pereira, vice-Coordinator (Prof N Jorge) and the Directors of the Research Units: Profs M Soares, J Seabra, X Viegas and J Barata. Profs X Viegas and J Seabra are also Vice-Presidents of LAETA

Scientific Coordinator and vice-Coordinator, and the Coordinators of Research Lines and Strands are elected by the Scientific Council. The Coordinators of group are elected by the Doctorates of the group, among the full Professors and Associate Professors with habilitation

The Directors of the Research Units are elected by all the Ph.D of the Research Units, among all full Professors

The Scientific Council is composed of the members of Executive Council, the coordinators of the Research Groups, the Coordinators of Research Lines and Strands, and three experts from major National industrial related institutions, (EFACEC, ISQ and A. Silva Matos)

The Coordinators of the Research Groups, Lines and Strands are members of the Scientific Council and provide the technical and scientific input that serves to ensure that LAETA meets the various scientific objectives that have been set

The Advisory Council is made up of 5 to 7 eminent international scientists. The council will convene every two years to review and evaluate LAETA's current strategic plan and propose strategic initiatives to foster and consolidate its development

The LAETA Scientific Assembly is composed by all doctorate researchers and will meet in a Research Workshop that will take place biennially in order to discuss the research results that have been achieved in the Lines and Groups and to identify any new strategic initiatives

6.4 Laboratory intensity level of the unit

High

Laboratory intensity level Justification

The LAETA laboratory infrastructures cover all areas of mechanical engineering. Special mention is placed on the following facilities:

IDMEC

Aerodynamic and Aeroacoustic-wind tunnel with anechoic chamber, flight simulator, cockpit of a Fokker F27 and supported by flight test instrumentation

Combustion -semi-industrial furnace 500kW for gas, solid or liquid fuels combustion

Manufacturing and Process Technology-metal forming, metal cutting, welding and joining, additive manufacturing and micro-fabrication machines. Metrology and material characterization units

Experimental Mechanics-testing machines for static and fatigue analysis under uni and biaxial loading conditions, supported by digital systems for strain measurement

Biomechanics-cameras for motion reconstruction and recording, force and pressure platforms with data acquisition systems, breathing gases analyser and a testing machine for biomechanics soft tissues

Vehicle and Propulsion Systems-dynamometer testing bench, gas analysers, vibration and data logger, fuel consumption meters and monitoring systems for electric vehicles

Composites-RTM, heated press and ultrasonic testing Mechatronics - robotic platforms, instrumentation and control devices

ADAI

Industrial Aerodynamics-wind tunnel, climatic chamber, engine test bed, roller test bench and a wide range of field, track and on site equipment for energy, thermal comfort and road vehicle testing

Fires-combustion tunnel, 2 canyon tables, a double slope table, a fire-whirl generator and test field for experimental fires

Detonics-explosion chambers, detonation advance measuring systems and explosive welding

AEROG

Aerodynamics and Propulsion- 2 wind tunnels (1 for flight dynamics), a 3-component aerodynamics balance and 2 turbine engines

Avionics, Control and Vibrations-flight simulator, complete landing gear and noise monitoring/analyser systems

INEGI

Indoor Air Quality- temperature, RH, air velocity and air exchange rate control, low flow sampling pumps, microbalance, sensors for concentration measurement, temperature and relative humidity and monitor systems for particulate matter

Structural Integrity- testing machines for static, fatigue, creep and a drop weight testing for medium to high rates of loading. Equipment for fracture mechanics testing, structural adhesive characterizing and experimental mechanics.

Material testing. Tribology. Vibration

Biomechanics- machines for static and dynamic testing of biological tissues and human locomotion analysis

New Materials and Manufacturing- filament winding, pultrusion and autoclave manufacturing equipment. High precision foundry. Sheet metal and electromagnetic forming

The number of PhD's engaged in experimental work is 50% of LAETA's integrated members(253). A significant number of publications involve both experimental and computational or theoretical work whilst a single global number of about 60% of LAETA scientific production is directly related to experimentation

6.5 General objectives

The general objective of LAETA is to apply R&D that supports the simultaneous implementation of the three-pillar bridge model along the innovation chain, from basic research, through technological research up to product development and prototyping.

LAETA's objectives will be focused on research to improve scientific knowledge with the goal of acquiring new competences and on development with the aim of promoting the dissemination of knowledge at post-graduate education, including PhD programs and advanced training. The laboratory also intends to promote partnerships with public and private institutions, SME's European consortia, national and international entities involved in regulation, standardization and R&D (orientated towards the provision of services).

Research will be performed by the 10 LAETA research groups and focussed on the 5 LAETA research Lines with the following objectives:

1- In the Energy field the objectives are to develop knowledge, technologies, processes and systems in the following sub-topics:

- i) Energy Efficiency (in buildings, in cities, in industry)
- ii) Low cost, Clean Energy Supply (renewables, clean combustion)
- iii) Energy storage (hydrogen and fuel cells, integrated systems)
- iv) Energy Planning and Market Uptaking (dissemination and capacity building, energy planning)

The basic research will focus on modelling issues of fluid flow, heat and reactive flows and the engineering research will be devoted to systems of great complexity. This latter contributes to improving scale facilities and scientific infrastructures in close cooperation with national and international partners. It is still necessary to incorporate the use of existing technologies in novel applications by means of the continuous improvement of energy efficiency in industries.

2- In the Transport Technologies field the objectives are to develop knowledge, technologies, processes and systems in Railway dynamics; Road vehicle dynamics and Passive safety. This entails four main sub-topics:

- i) Greener vehicles (electrical mobility, renewable vehicles)
- ii) Logistics (transport chains, intelligent control systems)
- iii) Safety and security (passive and active safety, enhanced automation)
- iv) Energy in Transports (thermal and acoustic comfort)

The R&D devoted to transport technologies will be related to rail and road applications that are resource-efficient, climate- and environmentally-friendly and safe. Several Research Groups will contribute towards resource efficient transport that respects the environment, (Green vehicles), and to improve mobility, removing congestion and enhancing safety and security. The objective is not only the development and integration of higher-performance technologies for critical structural components and traction (e.g. new materials, smart power and wireless technologies) but also the design and production solutions that best contribute to lean manufacturing and more efficient and safe operation of vehicles. The Urban, Logistics and Intelligent Transport Systems are specific areas that address the challenges arising from transport integration.

3- In the Aeronautics field the objectives are to develop knowledge, technologies, processes and systems in the following four sub-topics:

- i) Flight Physics (Aerodynamics and Propulsion, Emissions, Aero acoustics)
- ii) Flight Mechanics (Performance, Stability, Flight Simulation, Flight Tests)
- iii) Structures and Materials (Advanced Composites, Structural Health Monitoring)
- iv) Space (Space Technologies, Astrodynamics)

Research and innovation actions will target the development of methodologies that have the potential to save cost and time across the whole life cycle of an aircraft and will target the structural components of the aircraft, in particular. The research aims to develop innovative actions that target the reduction of emissions and noise at source (i.e. accelerating the development of green technologies for aircraft and aircraft engines).

4- In the Key Enable Technologies field the objectives are two-fold: (a) to provide engineering know-how to the 3 previous research lines in topics not directly covered by the researchers working in these areas and (b) to develop knowledge, technologies, processes and systems in the following six, major topics:

- i) Advanced Manufacturing (Mechanical and Thermal Processing of Materials; Polymer, Ceramic and Composite material processing; Lean, Agile and Life Cycle approaches to manufacturing).
- ii) Advanced Materials (Modelling and optimization of metallic, composites and ceramic materials; materials modelling; experimental Mechanics and non-destructive testing, medical materials and applications)
- iii) Biomechanics (Biomechanics and Mechanobiology of human tissues; Biomechatronics; Human Movement and design of medical devices)
- iv) Engineering Design (Integrated Design of Material & Structures; Multibody Dynamics; Material Simulation Design)
- v) Engineering Systems (Systems Design in Mechatronics; Automation and Systems Integration; Intelligent data-Based

Modelling, Control and Optimization)

vi) Fires (modelling of forest fires under extreme weather conditions; Detonics of advanced materials; development of non-lethal weapons; detection and disposal of explosives to improve security; assessment and improvement of fire safety in forest and urban fires)

In general, the overall aims and objectives are the following:

- Identification of new levels of understanding in current state-of-the-art subjects of the six major topics described above by means of theoretical and experimental methods and procedures.
- Development of innovative technologies, processes and systems taking advantage of the existing interdisciplinary competences in the six major topics above.
- Optimization and application of existing technologies, processes and systems to new materials, products and engineering solutions taking into account national and European requirements for environmentally sustainable development.

5- The objective of the R&D basic research on Future and Emerging Technologies in Energy, Transports and Aeronautics is to promote new ideas and support early stage, highly interdisciplinary research approaches with respect to:

- i) Aeronautical Morphing Technologies
- ii) Integrated analysis of novel aircraft configurations: flying wing, V-tail, joined wing
- iii) Ambient Assisted Living-ICT for Ageing
- iv) Systems Engineering in the Life Sciences
- v) New trends and methods in Computational Engineering

6.6 Implementation

The implementation plan begins by detailing the main topics and research groups that are involved in creating scientific knowledge and developing innovative technologies in the areas of Energy, Transports and Aeronautics. After this initial presentation, the plan outlines the strategic importance of ensuring a broad, multidisciplinary range of engineering competences in the area of Key-Enable Technologies. The area of Key-Enable Technologies is, firstly, introduced as an aggregation of the individual strategies of selected research groups and, then, presented as the vehicle that will effectively further LAETA's overall strategy

Energy

The plan for creating scientific knowledge and developing innovative technologies in this area is focused on: (i) energy efficiency, (ii) low cost, clean energy supply, (iii) energy storage and (iv) energy planning and market uptake.

The implementation plan comprises intervention of the groups in the following research topics:

- (i) Energy efficiency (buildings and cities (G2,G5,G7,G8); industry (G2,G5,G7,G8))
- (ii) Low cost, clean energy supply (renewables (G5,G7,G8), clean combustion(G5))
- (iii) Energy storage (hydrogen and fuel cells (G5), integrated Systems (G5,G7,G8))
- (iv) Energy planning and market uptaking (dissemination and capacity building (G5,G7, G8))

The area will be lead by Prof. E O Fernandes and will also take the interface with the area of Key-Enable Technologies into consideration.

Transports

The plan for creating scientific knowledge and developing innovative technologies in this area is focused on (i) greener vehicles, (ii) logistics and (iii) safety and security.

The implementation plan comprises intervention of the groups in the following research topics:

- (i) Greener vehicles (electrical mobility (G2, G5) and renewable energy vehicles (G4,G5))
- (ii) Logistics (transport chains (G2) and intelligent control systems (G2))
- (iii) Safety and security (passive and active safety (G3,G4,G6) and enhanced automation(G2,G7))

The area will be headed by Prof J Ambrósio, who will also be responsible for the interface with the area of Key-Enable Technologies.

Aeronautics

The plan for creating scientific knowledge and developing innovative technologies in this area is focused on (i) Flight Physics , ii) Flight Mechanics , iii) Structures and materials and iv) Space. The implementation plan comprise intervention of the groups in the following research topics:

- (i) Flight Physics (Aerodynamics, Emissions; Aero acoustics (G1,G5, G8, G9, G10), Aeroelasticity; Multidisciplinary design optimization (G1,G4,G6,G7,G10))
- ii) Flight Mechanics (Performance; Stability; Flight Simulation; Flight Tests, G1, G2, G10), System integration (G1))
- iii) Structures and materials (Advanced composites (G4,G6,G7), Structural health monitoring (G1,G3,G4,G6,G7))
- iv) Space (Space technologies (G1,G10) , Astrodynamics (G1,G10))

The area will be lead by Prof A Suleman, who will also be responsible for the interface with the area of Key-EnableTechnologies

Complementary and synergies among researchers and research groups in LAETA widens the scope of the mechanical engineering topics that are covered by comparison with smaller research institutions. This is of great importance in fulfilling the aims and objectives of this proposal due to the large range of topics and applications in Energy, Transport and Aerospace

Shared knowledge and extensive collaboration between researchers of LAETA - which in some cases amounts to more than 20 years of work in the laboratory - is also of great benefit for overall research purposes, namely with regard to sharing resources and fostering international partnerships

Key-Enable Technologies

The area of Key-Enable Technologies is built upon a wide range of multidisciplinary competences in the fields of advanced materials, engineering design, engineering systems, biomechanics, prevention of fires and detonics. The aim, in this respect, is to enlarge the traditional view of production technologies exclusively focused on manufacturing, assembly and operations research. This is necessary to implement the overall aims and objectives of LAETA with respect to transforming scientific knowledge and technologies developed in the areas of Energy, Transports and Aeronautics into useful and saleable products and processes.

All the research groups are involved in the area of Key-Enable Technologies in order to effectively tie the Key Enable Technologies to the areas of Energy, Transports and Aeronautics. However, there are six groups whose activities are mainly centred in this area as a result of their transversal role in LAETA. These groups are: Manufacturing and Industrial Management; Experimental Mechanics and New Materials, Intelligent Systems, Mechanical Design, Engineering Design Automation and Energy, and Forest Fires and Detonics.

Prof P Martins will head the strand of Advanced Manufacturing, which will be devoted to research, education, consultancy and internationalization. Research will be centred on the development of new (and the improvement of existing) manufacturing processes; on the application of existing manufacturing processes to new materials; and on the identification of new levels of understanding of manufacturing processes by means of theoretical and experimental methods and procedures. The emphasis in education will be focused on training of M.Sc. and Ph.D. students in manufacturing and industrial management. Applied research and engineering services will also play a significant role in the overall objectives of the area. Internationalization will be promoted by encouraging and stimulating research partnerships and visiting scholarships with leading international research institutions at both individual and group levels.

The research objectives of Advanced Manufacturing are primarily concerned with:

- (i) Mechanical and thermal processing of materials (G3,G4,G5)
- (ii) Polymer, ceramic and composite material processing and (G3,G4,G7,G6)
- (iii) Lean, agile and life cycle approaches to manufacturing (G3,G4,G6)

Prof A Ferreira will lead the strand of Advanced Materials which will involve all new metallic or non-metallic materials for all fields of Mechanical and Aeronautical Engineering. Metallic materials are crucial to all mechanical and aeronautical components, such as engines, gears, joints, shells, fuselages and so on. Another important example of metallic materials/structures is the development of metal foams for impact devices, in stand-alone or as sandwich cores. In strong competition with metallic materials, polymeric composites are at the forefront of recent developments in buses, automobiles and aeroplanes, satellites and other relevant areas. In combination with the traditional matrix/fibre organization of composite materials, recent developments in the field of nano-materials will improve mechanical, thermal, fire and other significant properties.

The research objectives of Advanced Materials are devoted to:

- i) Modelling and optimization of composites and ceramic materials (G4,G6,G7)
- ii) Micromechanics Materials modelling (G4,G6,G7)
- iii) Experimental Mechanics and non-destructive testing (G4,G6,G7)

Prof H Rodrigues will lead the strand on Biomechanics. The research groups that develop activities in these areas will join their scientific capabilities on mathematical, computational and experimental modelling, in order to push forward the frontier of knowledge in this multidisciplinary field and to contribute to societal challenges.

The research objectives of Biomechanics are chiefly concerned with:

- i) Biomechanics and Mechanobiology of human tissues (G3,G4,G5,G6,G7)
- ii) Biomechatronics (G2,G4,G6,G7)
- iii) Human Movement (G2,G4,G6,G7)

Prof P T de Castro will lead the strand of Engineering Design and will be able to draw on multidisciplinary contributions of from Computational mechanics, Experimental mechanics, Mechanical behaviour of materials, New paradigms in New Product Development, Optimization, and Tribology

The research objectives of Engineering Design are focused on:

- i) Integrated Design of Material Structures (G1,G3,G4,G6,G7)
- ii) Structural and Multibody Dynamics (G1,G4,G6)
- iii) Material Simulation and Design (G4,G6,G7)

Prof J Sousa will lead the strand of Engineering Systems which is an approach for design and analysis of complex engineering problems based on the theory of dynamic systems, taking account of its multidisciplinary character. This thematic line has the objective of applying this multidisciplinary and systemic design and analysis to several complex problems currently addressed in the research groups of LAETA and in the other thematic lines. The research and development of the Engineering Systems thematic line will be focused on the following topics:

- i) Systems Design in Mechatronics (G2,G7,G8)
- ii) Automation and Systems Integration (G2,G7,G8)

iii) Intelligent data -based modelling, control and optimization (G2, G7,G8)

Prof X Viegas will lead the strand on Fires with the goal of improving experimental and computational capabilities so as to increase the line's competitive position at international level aiming to participate in national and international programmes. The Fires line will also promote contracts with industrial partners and with international research and advanced education programmes and will organize workshops and seminars to stimulate new researchers and disseminate ongoing research.

The research objectives are:

- i) Forest Fires modelling under extreme weather conditions; and urban fires (G5,G9)
- ii) Fire safety in forest (G5,G9)
- iii) Detonics (G9)

The research groups will contribute to these strands in topics that are available in the individual description of each research group

The area of Key-EnableTechnologies will be headed by Prof J Pereira, who is also the PI due to the importance of this area within the overall strategy of LAETA

6.7 Contributions for the regional strategy

Research, technological development and innovation are also key to fostering greater competitiveness at a regional level. Smart specialisation involves developing a strategic vision of the future, identifying competitive advantages and setting the priorities for research and innovation at a specifically regional level. Against this background, universities and higher education institutions have a central role to play in furthering smart specialisation strategies as this supposes a number of stages. These include the identification of regional added value, assistance in the development of regional innovation plans and the assumption of a guiding role during implementation.

Similarly, LAETA has a significant role in the Portuguese economy as a whole, given the already established, deep and active cooperation between the various research units and a series of Portuguese companies (e.g. in the fields of transport, energy and the manufacturing sectors). Such cooperation will be crucial in re-launching the Portuguese economy.

The units of LAETA are located in Lisbon (Region of Lisbon and Vale do Tejo), Porto (North Region), Coimbra (Centre Region) and Covilhã (Centre Region). As a result, LAETA benefits from its covering several regions in Portugal whilst providing the necessary critical mass to develop research activities characterised by outstanding excellence. In so doing, LAETA based research units will contribute directly and significantly to regional development given that they will be structured around leading conurbations (Lisbon, Porto, Coimbra and Covilhã). Energy and transport are essential to these metropolitan regions and the ideas developed in this context can be directly applied at these regional levels. For instance, IDMEC has cooperated in the design of the North Region plan for Sustainable Energy and has a long-term relationship with AdePorto, currently developing sustainable energy plans for nine municipalities of the Porto Metropolitan area.

An additional benefit is that work undertaken in these fields will foster the growth of a tissue of innovative start-ups and SMEs. Indeed, urban areas around universities, in general, represent an excellent environment for start ups, enabling them to go on to flourish.

More particularly, in the different regions, LAETA will contribute to the following objectives (as described in the respective regional innovation plans:

- Lisbon and Vale do Tejo:

Urban requalification
Low carbon economy
Environmental services
Production systems
Social Innovation

- North Region

Transports, including Aeronautics, Mobility and Environment
Key Enable Technologies: Advanced Manufacturing and Materials
Technological developments related to active ageing; biomedicine.
Maritime Technologies (Off-shore Energy production)
Systems Engineering

- Centre Region
Maritime Technologies
Information and Communication Technologies
Materials
Health and Wellbeing

6.8 Opportunities for advanced training

It is important to foster the development of advanced training within the knowledge triangle and this means ensuring that training is coupled to both university research centres and the industrial and commercial sectors. LAETA contributes to advanced education that covers the whole of the knowledge triangle and this enables the laboratory to pursue close collaboration with Portuguese industry and with a wide range of international partners.

One of the direct advantages of such cooperation is that the students are able to gain valuable experience of different environments whilst working in an environment conducive to the development of an entrepreneurial and life learning attitude. The students also benefit from a large national network composed of the various LAETA institutes spread across the country and, in this respect, mobility between research units represents a significant advantage as students complete a specific training programme.

LAETA research groups participate in the MIT Portugal Ph.D. programs on "Engineering design and advanced manufacturing", "Sustainable Energy Systems" and "Bioengineering", and also in the PhD on "Computational engineering" in the framework of the UT Austin Portugal programme and Erasmus Mundus programme. Moreover, a number of the research groups in LAETA participate in KIC Innoenergy: a part of the European Institute of Innovation and Technology, a European flagship in advanced training projects. This will serve as a bedrock for ambitious programmes in the field of advanced training in the future.

The thematic strand in Key Enable Technologies is committed to high-education and will create a new Ph.D. programme aimed at promoting the research-based education of highly skilled production engineers. These engineers will be capable of dealing with the engineering challenges and opportunities of transforming knowledge into advanced industrial components and systems for the energy, transports and aeronautics industries in order to create new jobs and more added value for national and European industries.

The advanced knowledge developed by LAETA researchers is included in training programmes for under graduates and post-graduates and will contribute to upgrading their technical capacity and improving their skill-base. This will be achieved through specialized training courses, publications and seminars.

Based on the research and development of LAETA different advanced training courses have been offered for industry. Among these:

- Railway Dynamics, 48 hours; IST, 2010
- Advanced Design of Mechanical Systems: From Analysis to Optimization; 32 hours CISM, Udine, Italy, 2008

6.9 Internationalization

LAETA has strong national and international collaborative links with a wide number of national and international universities, research institutions and companies. The following represents a short summary containing some of the most important collaborative links in the thematic areas of LAETA (and has been preferred to the presentation of a long and exhaustive list of names):

In the thematic areas of Transports, Aeronautics and Space the most important collaborative links comprise the following institutions:

University of Texas, Austin
Technical University of Denmark
University of Michigan, USA.
University de Zaragoza, Spain.
University of Seville, Spain
Aerospace Technology Institute (Instituto Tecnológico de Aeronáutica), São José dos Campos, Brasil
University Federal do Rio de Janeiro, Brasil
National Aeronautics and Space Administration
US Air Force Research Laboratory.
Airbus
Rolls-Royce
Daimler AG
TU Delft
TU Munich
Imperial College London

In the area of Energy, the most important collaborative links comprise the following institutions:

MIT, USA
Federal University of Santa Catarina, Brazil
University of Lund, Sweden
University of Haifa, Israel
University of Aachen, Germany
University of Duisburg-Essen, Germany

In the area of Key enable technologies the most important collaborative links comprise the following institutions:

MIT, USA
Technical University of Eindhoven, the Netherlands

University of Michigan, USA
University de Zaragoza, Spain
Delft University of Technology, the Netherlands
Siemens AG, Munich, Germany
Technical University of Denmark
Technical University of Dortmund, Germany
Federal University of Rio Grande do Sul, Brazil
TWI Ltd, UK
MCG Mind for Metal, Portugal
Siemens, Portugal
European Space Agency
University of Wales Swansea, U.K
Universitat Politècnica de Catalunya, Spain
CEMEF - MINES ParisTech, Sophia Antipolis, France
Stanford University

The institute intends to reward mobility of researchers and joint publications with international leading research groups. The institute will also reward those research institutes that have been able to access international funding as well as the ability to diversify funding in a global context. Finally, the institute actively encourages the participation of the members of the institute in leading conferences and seminars as this will enhance the visibility of LAETA

6.10 Knowledge transfer

Research and innovation are the foundation on which renewed economic development and job creation can be built. Advancements in science are crucial to the improvement of our quality of life as this includes such matters of direct concern as access to clean energy or the fight against climate change. Improvements in the quality of life cannot be attained without excellent research that, at the same time, will directly lead to growth.

The institute seeks to encourage the integration of post-doctoral and doctoral students in the wider economy. This has a number of advantages, an example of which is that a post-doctoral student who is employed in a company will effectively transfer his or her acquired knowledge to that company. Alongside encouraging the employment of post-graduate students, the institute will seek to develop a dynamic exchange of ideas between the academic, the economic and industrial worlds as this entails the organization of seminars, conferences and training courses. Another possibility that the institute is eager to exploit is that of encouraging post-graduate students to set up new companies that exploit their acquired knowledge and skills.

Finally, the institute also intends to promote the active registering of patents that will allow innovative ideas to find a rewarding, commercial outlet. To this end, LAETA will create a small knowledge transfer centre that will liaise with the knowledge transfer centres of the universities where LAETA research units are located and that will assist researchers in the following areas:

1. Exploiting opportunities for transfer of know-how, data and results
2. Patent protection
3. Licensing
4. Creation of Spin-outs
5. Industry contracts and consultancy
6. Intellectual Property Rights
7. Development of Knowledge Transfer policy

6.11 Ethical issues

The flourishing but complex nature of modern science is not immune to a range of sometimes quite thorny ethical considerations. It is as important today as it has been in the past that the impact of scientific development on the environment, on individuals and communities is actively taken into consideration.

In this respect, LAETA intends to pursue research in compliance with existing and future national regulations and international codes of conduct as these cover such domains as the protection of personal data or the fundamental ethical values defined by such organizations as the European Centre for Fundamental Rights. Similarly, LAETA will abide by the opinions published by the European Group of Ethics in Science and New Technologies (EGE) of the European Commission, especially in the areas of Energy and New Materials (Opinion N° 27: an ethical framework for assessing research, production and the use of energy).

As far as misconduct in science is concerned, LAETA intends to continue to pursue a policy based on the highest ethical standards and principles of responsibility as this necessarily supposes the elimination of any misconduct in the scientific domain. It is also of considerable importance that these principles are transmitted to post-graduate students and other researchers working in LAETA.

7. EXPECTED INDICATORS OF THE STRATEGIC PROGRAMME 2015/2020

7.1

Description	2015	2016	2017	2018	2019	2020	TOTAL ()
Publications in peer-review international journals	364	372	382	405	416	426	2365
Patents and performing patents	7	8	11	6	9	11	52
Books and chapters of international distribution	35	35	41	37	44	46	238
PhD theses under the supervision of integrated members	34	39	46	44	48	48	259
Conference proceedings	476	495	497	521	518	538	3045
New materials, devices, products and processes, software, computer codes and algorithms	39	40	35	39	40	41	234
Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)	10	12	16	7	11	12	68
Edited special issues of journals, with substantial research input on the part of the researcher	4	6	5	3	7	5	30
Chapters in books, including contributions to conference proceedings, essays in collections	18	20	21	23	21	22	125
Creative writing (to the extent that it embodies research)	1	1	1	1	1	1	6
Dictionary entries (forming part of investigation)	0	0	0	0	0	0	0
Encyclopedia entries (to the extent that they embody research)	0	0	0	0	0	0	0
Audio/visual and electronic/digital materials	2	2	4	4	4	2	18
Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)	3	6	6	5	4	7	31
Performances and exhibitions to the extent that they embody research	11	13	13	13	14	12	76
Industrial research contracts	30	33	35	37	41	40	216
Research contracts with national or international bodies	72	71	75	74	75	73	440

8. PROPOSED RESEARCH TEAM

8.1 Criteria adopted by the R&D unit for the definition of integrated member, if different from FCT reference table

LAETA has created a narrower set of scientific criteria than those outlined by FCT and has not considered conference publications as eligible. The reason for the exclusion of conference publications is the difficulty involved in ranking conferences with or without abstract or full paper reviewing processes. The criteria adopted are:

- Four indicators of scientific production (publication of articles in international peer reviewed journals, patents, books and chapter of books) over the last 5 years (2008/2012). More than 96% of LAETA's associated members fulfil this criteria.
- Over the last 5 years, a small number of researchers, (less than 4% of the members) have developed a technologically oriented profile. They play a crucial role in LAETA laboratories and, in this respect, the above rule has been relaxed to allow a number of six scientific indicators (including models and prototypes) whilst still excluding conference publications.

8.2 List of Integrated Members / 10 nuclear CVs

Name	Nuclear CV
José Carlos Fernandes Pereira (Coordinator)	Yes
ANTONIO JOSE CAETANO BAPTISTA	No
Abel Dias dos Santos	No
Abílio Manuel Pinho de Jesus	No
Adélio Manuel Rodrigues Gaspar	No

Afzal Suleman	No
Agostinho Rui Alves da Fonseca	No
Alberto Sérgio de Sá Rodrigues Miguel	No
Alexandra Bento Moutinho	No
Alfredo da Silva Ribeiro	No
Almerindo Domingues Ferreira	No
Ana Maria Azevedo Neves	No
Andre Calado Marta	No
André Ferreira Costa Vieira	No
André Resende Rodrigues Silva	No
André Ricardo Maia Correia	No
André Rui Dantas Carvalho	No
Antonio Augusto Fernandes	No
Antonio Eduardo de Barros Ruano	No
Antonio Franco de Oliveira Falcao	No
Antonio Manuel Gameiro Lopes	No
Antonio Paulo Monteiro Baptista	No
Antonio Rui de Almeida Figueiredo	No
Antonio Torres Marques	No
António Manuel Ferreira Mendes Lopes	No
António Manuel Relógio Ribeiro	No
António Rui de Oliveira Santos Silva Melro	No
Arlindo José de Pinho Figueiredo e Silva	No
Armando José Vilaça de Campos	No
Augusto Duarte Campos Barata Rocha	No
Aurélio Lima Araújo	No
Avelino Virgílio Fernandes Monteiro de Oliveira	No
Barbara Perry Pereira Alves Gouveia Almeida	No
Carla Alexandra Monteiro da Silva	No
Carla Maria da Cunha Roque	No
Carlos Alberto Conceicao Antonio	No
Carlos Alberto Mota Soares	No
Carlos Batista Cardeira	No
Carlos Frederico Neves Bettencourt da Silva	No
Carlos Manuel Alves da Silva	No
Carlos Pinto Moreira de Sá	No
Carmen Marisa Marques Gonçalves	No
Catarina Rosa Santos Ferreira de Castro	No
Catarina Sofia da Costa Nunes Duarte	No
Celeste Margarida Correia Pereira	No
Celestino Rodrigues Ruivo	No
Claudio Saul Faria Lopes	No
Cláudia Sofia Séneca da Luz Casaca	No

Cristina Maria Nogueira Romão	No
Cristóvão Manuel Mota Soares	No
César Miguel de Almeida Vasques	No
Divo Augusto Alegria Quintela	No
Domingos Xavier Filomeno Carlos Viegas	Yes
Duarte Pedro Mata de Oliveira Valério	No
Eduardo Guimaraes de Oliveira Fernandes	No
Elsa Maria Pires Henriques	No
Elza Maria Morais Fonseca	No
Eusebio Zeferino Encarnacao Conceicao	No
FRANCISCO JORGE TEIXEIRA DE FREITAS	No
Fausto Miguel Cereja Seixas Freire	No
Fernando Gomes de Almeida	No
Fernando Jorge Lino Alves	No
Fernando Jose Ferreira	No
Fernando José Parracho Lau	No
Filipa Andreia de Matos Moleiro	No
Filipe José Palhares Chaves	No
Filipe Szolnoky Ramos Pinto Cunha	No
Francisco José Gomes da Silva	No
Francisco M. M. C. Vasques Carvalho	No
Francisco Manuel Andrade Pires	No
Francisco Miguel Ribeiro Proença Brojo	No
Gabriela Ventura Alves da Silva	No
Giuseppe Catalanotti	No
Goncalo Nuno Antunes Goncalves	No
Gonçalo Jorge Vieira Nunes Brites	No
Heitor Lobato Girão Pina	No
Helder Carrico Rodrigues	No
Hernani Miguel Reis Lopes	No
Hugo Miguel Inácio Pousinho	No
Hugo Queiros de Faria	No
Ines da Fonseca Pestana Ascenso Pires	No
Inês Ribeiro	No
Isabel Maria Pereira Bastos Malico	No
JAIME MIRANDA MONTEIRO	No
Jaime Duarte Rodrigues	No
Joao Evangelista Barradas Cardoso	No
Joao Manuel Gouveia de Figueiredo	No
Joao Manuel Melo de Sousa	No
Joao Manuel Pereira Dias	No
Joaquim Gabriel Magalhães Mendes	No
Joaquim Infante Barbosa	No

Joaquim Manuel Guerreiro Marques	No
Jorge Alberto Cadete Ambrosio	Yes
Jorge Americo Oliveira Pinto Belinha	No
Jorge Humberto Oliveira Seabra	Yes
Jorge Manuel Martins Barata	No
Jorge Manuel Mateus Martins	No
Jorge Manuel da Conceicao Rodrigues	No
Jorge Miguel dos Reis Silva	No
Jose Augusto Goncalves Chousal	No
Jose Augusto Trigo Barbosa	No
Jose Duarte R. Marafona	No
Jose Jorge Lopes Da Cruz Fernandes	No
Jose Manuel Baranda Moreira Da Silva Ribeiro	No
Jose Manuel Mota Couto Marques	No
Jose Manuel de Almeida Cesar de Sa	No
Jose Mateus Simoes Moita	No
José Arnaldo Pereira Leite Miranda Guedes	No
José Augusto de Sousa Ferreira Brandão	No
José Carlos Miranda Góis	No
José Carlos Reis Campos	No
José Castela Torres da Costa	No
José Fernando Dias Rodrigues	No
José Firmino Aguilár Madeira	No
José Joaquim da Costa	No
José Leandro Simões de Andrade Campos	No
José Leonel Monteiro Fernandes	No
José Luís Soares Esteves	No
José Manuel Estevão Costa	No
José Manuel Gutierrez Sá da Costa	Yes
José Manuel Lopes Texeira Amarante	No
José Manuel da Silva Chaves Ribeiro Pereira	No
José Miguel Almeida da Silva	No
José Viriato Araújo dos Santos	No
João Carlos Antunes Sampaio Fernandes	No
João Carlos Eloi de Jesus Pombo	No
João Carlos Gonçalves	No
João Carlos Gonçalves Ferreira de Pinho	No
João Carlos Prata dos Reis	No
João Carlos de Campos Henriques	No
João Eduardo Pinto Castro Ribeiro	No
João Filipe de Almeida Milho	No
João Luis Toste de Azevedo	No
João Manuel Abreu dos Santos Baptista	No

João Manuel Ferreira Calado	No
João Manuel Nogueira Malça de Matos Ferreira	No
João Manuel Ribeiro da Silva Tavares	No
João Miguel Costa Sousa	No
João Orlando Marques Gameiro Folgado	No
João Pedro Barata da Rocha Falcão Carneiro	No
Kouamana Bousson	No
Lucas Filipe Martins da Silva	No
Lucia Maria Jesus Simas Dinis	No
Luis Filipe Galvão dos Reis	No
Luis Manuel Braga da Costa Campos	Yes
Luis Manuel Fernandes Mendonça	No
Luis Manuel Guerra Silva Rosa	No
Luis Manuel Martins Leite de Magalhaes	No
Luis Manuel Ventura Serrano	No
Luis Manuel dos Santos Redondo	No
Luis Rego da Cunha de Eca	No
Luisa Maria Pimenta Abreu Costa Sousa	No
Luís Alberto Gonçalves de Sousa	No
Luís António de Andrade Ferreira	No
Luís Manuel Mendonça Alves	No
Luís Manuel de Carvalho Gato	No
Luísa Natália da Encarnação Hoffbauer	No
MARIA TERESA DA QUINTA E COSTA MASCARENHAS SARAIVA	No
Manuel Afonso da Fonte	No
Manuel António Pereira Gutierrez	No
Manuel Carlos Gameiro da Silva	No
Manuel Frederico Oom Seabra Pereira	No
Manuel Jorge Dores de Castro	No
Manuel José Moreira Freitas	No
Manuel Rodrigues Quintas	No
Manuel Romano dos Santos Pinto Barbosa	No
Marcelo Francisco de Sousa Ferreira de Moura	No
Marco Paulo Lages Parente	No
Maria Alexandra Sousa Rodrigues	No
Maria Amélia Ramos Loja	No
Maria Arcelina Marques	No
Maria Beatriz Cipriano de Jesus Silva	No
Maria Cristina dos Santos Ribeiro	No
Maria Emilia da Encarnacao Rosa	No
Maria Fernanda Gentil Costa	No
Maria Helena Guimarães Figueiral da Silva	No
Maria Luisa Coutinho Gomes Almeida Quintino	No

Maria Luisa Romariz Madureira	No
Maria Margarida Fernandes Machado	No
Maria Teresa Braga Valente de Almeida Restivo	No
Maria da Graca Martins da Silva Carvalho	Yes
Maria de Fátima Castro Chouzal	No
Maria de Fátima Reis Vaz	No
Mariana Doina Banea	No
Mariana Rita Ramos Seabra	No
Mario Augusto Pires Vaz	No
Marta Ilda Laranjeira Lopes de Oliveira	No
Miguel Abrantes de Figueiredo Bernardo de Almeida	No
Miguel Afonso Dias Ayala Botto	No
Miguel Antonio Lopes de Matos Neves	No
Miguel Pedro Tavares da Silva	No
Mário Manuel Gonçalves Costa	No
Mário Rui Melício da Conceição	No
NUNO MIGUEL ROSA PEREIRA SILVESTRE	No
Nannan Song	No
Nuno Alexandre Gonçalves Martinho	No
Nuno Alexandre de Oliveira Calçada Loureiro	No
Nuno André Curado Mateus Correia	No
PAULO ANTÓNIO FIRME MARTINS	Yes
PEDRO ALEXANDRE RODRIGUES CARVALHO ROSA	No
Patricia Alexandra Barroso da Fonseca	No
Patrícia de Carvalho Baptista	No
Paulo Alexandre Gonçalves Piloto	No
Paulo Augusto Ferreira de Abreu	No
Paulo Jorge Coelho Ramalho Oliveira	No
Paulo Jorge Sequeira Gonçalves	No
Paulo Jorge Soares Gil	No
Paulo Jose da Silva Tavares	No
Paulo José da Costa Branco	No
Paulo Manuel Salgado Tavares Castro	No
Paulo Miguel Nogueira Pecas	No
Paulo Rui Alves Fernandes	No
Pedro Alexandre Lopes de Sousa Martins	No
Pedro Jorge Martins Coelho	No
Pedro Manuel Cardoso Teixeira	No
Pedro Manuel Leal Ribeiro	No
Pedro Manuel Ponces Rodrigues Castro Camanho	Yes
Pedro Manuel da Silva Cardoso Isidro Valente	No
Pedro Miguel Gomes Abrunhosa Amaral	No
Pedro Miguel Guimarães Pires Moreira	No

Pedro Vieira Gamboa	No
Rafael Sousa Costa	No
Ramiro Carneiro Martins	No
Renato Manuel Natal Jorge	No
Ricardo Angelo Rosa Vardasca	No
Ricardo Antonio Lopes Mendes	No
Ricardo António Lamberto Duarte Cláudio	No
Ricardo Miguel Gomes Simões Baptista	No
Rosa Maria Marquito Marat Mendes	No
Rui Jorge Sousa Costa de Miranda Guedes	No
Rui Manuel dos Santos Oliveira Baptista	No
Rui Pedro Cardoso Silva Martinho	No
Rui Pedro Chedas de Sampaio	No
Rui Pedro da Costa Neto	No
Sandra Maria de Brito Monteiro de Melo	No
Sofia-Natalia Boemi	No
Susana Margarida da Silva Vieira	No
Susana de Almeida Mendes Vinga Martins	No
Sérgio Manuel Oliveira Tavares	No
Sónia Liliana da Silva Vieira	No
Teresa Margarida Guerra Pereira Duarte	No
Teresa Maria de Serpa Pinto Freitas do Amaral	No
Tiago Alexandre Abranches Teixeira Lopes Farias	No
Vasco Manuel Ferreira Tameirão Montenegro Granadeiro	No
Vasili Andreevich Sarychev	No
Virginia Isabel Monteiro Nabais Infante	No
Viriato Sérgio Almeida Semião	No
Vítor Manuel da Silva Leal	No
ana rosanete lourenco reia	No
antonio joaquim mendes ferreira	Yes
carlos sousa casimiro da costa	No
jose raul carreira azinheira	No
nuno manuel mendes maia	No

9. PROPOSED RESEARCH GROUPS

Reference	Name	Principal Investigator
RG-50022-1571	Aerospace Science and Technology	Luis Manuel Braga da Costa Campos
RG-50022-1619	Intelligent Systems	João Miguel Costa Sousa
RG-50022-1620	Manufacturing and Industrial Management	PAULO ANTÓNIO FIRME MARTINS
RG-50022-1622	Mechanical Design	Helder Carrico Rodrigues
RG-50022-1624	Renewable and Sustainable Energy Systems	Mário Manuel Gonçalves Costa
RG-50022-1625	Engineering Design, Automation and Energy	Antonio Augusto Fernandes

RG-50022-1627 Energy, Environment and Comfort

RG-50022-1628 Forest Fires and Detonics

RG-50022-1630 Aeronautics and Astronautics

RG-50022-2178 Experimental Mechanics New Materials and Manufacturing

Manuel Carlos Gameiro da Silva

Domingos Xavier Filomeno Carlos Viegas

Kouamana Bousson

Mario Augusto Pires Vaz

(RG-50022-1571) Aerospace Science and Technology

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1571

9.1.2 Name of the Research Group in portuguese

Ciência e Tecnologia Aeroespacial

9.1.3 Name of the Research Group in English

Aerospace Science and Technology

9.1.4 Keyword(s)

Aerospace Engineering

Aeroacoustics

Space Science and Technology

Adaptive Structures

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica (IDMEC)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
Luis Manuel Braga da Costa Campos	Yes	Yes
Afzal Suleman	No	Yes
Agostinho Rui Alves da Fonseca	No	No
Andre Calado Marta	No	No
Fernando José Parracho Lau	No	No
Filipe Szolnoky Ramos Pinto Cunha	No	No
Joaquim Manuel Guerreiro Marques	No	No
Paulo Jorge Soares Gil	No	Yes

9.2.2 List of current PhD students

NAME

Frederico José Prata Rente Reis Afonso
Simão Santos Rodrigues
Anibal da Luz Santos Mota
Fernando Virgilio Pires de Oliveira
Abdolrasoul Sohoul
Frederico André Branco dos Reis Francisco

9.2.3 List of other researchers of the Research Group

NAME

João Manuel Gonçalves de Sousa Oliveira
Pedro da Graca Tavares Alvares Serrao
José Lobo do Vale

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

The Group has been active in the following areas:

1 - Book Series by CRC Press

L. M. B. C. Campos is editor and author of the series: "Mathematics and Physics Applied to Science and Technology published by CRC Press. Three volumes have been completed so far.

2 - AEROACOUSTICS

This area involves most members of the group, that is one of the most productive worldwide in publications in aeroacoustics, covering a variety of topics:

- acoustics of non-uniform (sheared and or swirling) flows;
- sound transmission in turbulence and wind;
- sound generation by propellers, rotors and combustion;
- acoustics of ducts, inlets and nozzles with uniform and non-uniform liners;
- acoustics of boundary-layers and aircraft cabin noise;
- passive and active noise reduction;
- non-linear sound, shock waves and relaxing media;
- diffraction by obstacles and noise shielding;
- aerodynamic noise of aircraft and wind turbines.

3 - ADAPTIVE AND MORPHING STRUCTURES

Includes morphing airfoils and wings, piezoelectric materials and optimization of aerodynamic, structural and aeroelastic performance.

4 - DYNAMICS OF ATMOSPHERIC AND SPACE FLIGHT

Includes:

- flight stability, control and handling qualities;
- novel aircraft configurations: flying wing, joined wing, V-tail, noise shielding;
- cruise drag minimization;
- control power maximization in emergency situations, e.g. engine failure;
- rocket trajectories in the atmosphere;
- orbital insertion

5 - AIR TRAFFIC MANAGEMENT

Research concentrates on the capacity and safety issues in the two main phases of flight:

- Wake vortex separation at take-off and landing that determines the capacity of runways and airports;
- Separation in en-route flight to ensure low probability of collision through accurate positioning and allow high traffic density.

6 - SPACE SCIENCE AND TECHNOLOGY

Includes:

- magnetohydrodynamics of the solar-terrestrial system and stars;

- cosmological models of the large-scale universe;
- quantum-gravity models of fundamental interactions.
- planning of space missions.
- satellite technology

7 - MATHEMATICS

L.M.B.C. Campos is contributor to "Mathematical Reviews" (10 reviews) mostly on special functions and the fractional calculus.

Research on:

- Special functions and differential equations;
- Non-linear models of the evolution of populations.

8 - FLIGHT TESTING AND SIMULATION:

Includes:

- Operation of a wind tunnel with closed circuit 10 x 15 m, speed up to 50 m/s, turbulence level 0,3%, open test section diameter 1.2 m in a 4 x 5 x 6 m³ anechoic chamber for simultaneous acoustic, aerodynamic and force/moment tests on a model.

- Operation of a 6 degree-of-freedom flight simulator, with Stewart-type electric motion base, regional aircraft cockpit, digital flight instrumentation and computer generated imagery.

Flight testing of government and private aircraft, including monitoring of the quality of satellite navigation signals (EGNOS/GALILEO) in the Lisbon - Azores FIR (Flight Identification Region) for the European Union/European Space Agency/Eurocontrol.

9 - AIRCRAFT AND COMPONENT DESIGN

- multidisciplinary design optimization (MDO)
- novel aircraft configurations
- stability of flying wings
- control of V-tails
- structural aspects of joined wings
- multidisciplinary design optimization
- level set methods
- system integration and green UAV design

10 - AERODYNAMICS AND PROPULSION

- helicopter aerodynamics
- morphing airfoils and wings
- flight in atmospheric disturbances

9.3.2 Main achievements

1 - CRC SERIES "MATHEMATICS AND PHYSICS APPLIED TO SCIENCE AND TECHNOLOGY"

L.M.B.C. Campos is both editor and author of this series of volumes.

1st volume "Complex Analysis with applications to Flows and Fields", 1029 p, published in 2011.

2nd volume "Transcendental Representations with Applications to Solids and Fluids", 898 p, published in 2012.

3rd volume "Generalized Calculus with applications to Matter and Forces", 885 p, in press and due to appear early 2014. Further volumes are planned for the period 2015-2020.

2 - AEROACOUSTICS

Duct acoustics:

Int J Acoustics and Vibration 13, 100-111, 2008.

Active noise reduction:

Int J Acoustics and Vibration 14, 150-162, 2009.

Acoustics of shear flows:

AIAA Journal 48, 878-892, 2010.

Int J Aeroacoustics 12, 125-170, 2012.

J Sound Vib 330, 1166-1195, 2011.

Sound generation:

Int J Aeroacoustics 11, 103-136, 2011.

Sound in turbulence:

Int J Aeroacoustics 11, 475-520, 2012.

Acoustic liners:

Int J Aeroacoustics 12, 189-227, 2013.
Proceedings of the Royal Society (to appear).

Acoustics of swirling flows:
International Journal of Aeroacoustics (to appear).

plus 30 communications to symposia.

3 - ADAPTIVE AND MORPHING STRUCTURES
J. Int. Mat. Syst. Struct. 22, 1057-1073.

4 - DYNAMICS OF ATMOSPHERIC AND SPACE FLIGHT

Aerothermodynamics:
Acta Astronautica 64, 971-978, 2009.

Rocket trajectories:
Progress on Mathematics for Industry at ECMI 2008, Springer, 739-746, 2010.

Wake vortex response and separation:
Progress in Mathematics for Industry at ECMI 2008, Springer, 747-752, 2010.
3rd Sesar Innovation Days, KTH. Stockholm, 2013.

plus 6 communications to symposia.

5 - AIR TRAFFIC MANAGEMENT

Probability of collision:
Progress in Industrial Mathematics at ECMI 2008, Springer, 753-758, 2010.
Aircraft Engineering and Aerospace Technology 83, 306-314, 2011.

Air traffic capacity:
Aeronautics and Astronautics, editor M. Mulder, 571-588, Intech, 2011.

plus 6 communications to symposia.

6 - SPACE SCIENCE AND TECHNOLOGY

Space Science:
Geophysical and Astrophysical Fluid Dynamics 102, 51-74, 2008.
Journal of Mathematical Physics 52, 013508-1 to -26, 2011.
Monthly Notices of the Royal Astronomical Society 410, 717-734, 2011.
Monthly Notices of the Royal Astronomical Society 410, 735-761, 2011.
Joint European and National Meeting in Astronomy, Sept 6-10, Lisbon, 2010.

plus 3 communications to symposia.

Space technology:
Phys. Rev. D 78 (10), 103001, 2008.
Experimental Astronomy 23(2), 651-687, 2009.
Space Sci. Rev. 151 (1-3), 75-91, 2010.
Journal of Guidance, Control, and Dynamics 33 (3), 901-914, 2010.
Expert Systems with Applications 39(9), 7701-7708, 2012.
International Journal of Modern Physics D 21(4), 1250035, 2012.
Phys. Lett. B 711(5), 337-346, 2012.

7 - MATHEMATICS

Population problem:
Non-linear Studies 18, p 235-254, 2011.

Special functions:
Journal of Inequalities and Special Functions 3, p 1-28, 2012.
10 reviews by L.M.B.C. Campos as a contributor to "Mathematical Reviews", mostly on special functions and the fractional calculus.

8 - FLIGHT TESTING AND SIMULATION:

Operational evaluation and monitoring of quality of satellite navigation signals (EGNOS/GALILEO) in the Lisbon FIR (Flight Identification Region) up to Azores.

9 - AIRCRAFT AND COMPONENT DESIGN

Aircraft optimization:

ICAS 2008 Anchorage, Alaska.

ICAS 2010, 19-24 Sept, Nice.

Component design:

Int J Eng Science 48, p 718-725, 2010.

17th ASC-CEAS/X-NOISE EV Workshop, Seville, 2013.

plus 2 communications to symposia.

10 - AERODYNAMICS AND PROPULSION

Computers & Fluids, 39 (9), 1562-1574, 2010.

J. Vib. Acoust. 133 (5)

Non-linear Studies 11, p 1-17, 2012.

plus 5 communications to symposia.

Publications for all areas in the: year 2008+2009+2010+2011+2012=Total

Books = 0+0+0+1+1=2

Papers in international referee journals: 4+3+5+8+5=25

Communications to international symposia: 17+11+28+5+12=75

Research contracts: 3+1+2+3+1=10

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

1. L. M. B. C. Campos & M. H. Kobayashi (2008) "On the propagation of sound in a high-speed non-isothermal shear flow", International Journal of Aeroacoustics, Volume 8, pages 199-230. (IF= 0.627; no C=3)
2. J. Vale, A. Leite, F. Lau, & A. Suleman (2011), "Aero-Structural Optimization and Performance Evaluation of a Morphing Wing with Variable Span and Camber", Journal of Intelligent Material Systems and Structures, Vol 22 (10), 1057-1073. (doi:10.1177/1045389X11416031). (IF= 1.523; no C=1)
3. L. M. B. C. Campos & J. M. G. S Oliveira (2011), "On the acoustic modes in a duct containing a parabolic shear flow", Journal of Sound and Vibration, Volume 330, pages 1166-1195, 2011. doi:10.1016/j.jsv.2003.06.035. (IF= 1.613; no C=2)
4. O. Bertolami, F. Francisco, P. J. S. Gil, J. Páramos (2008), "Thermal Analysis of the Pioneer Anomaly: A Method to Estimate Radiative Momentum Transfer", Phys. Rev. D 78 (10), 103001, DOI: 10.1103/PhysRevD.78.103001, e-Print: arXiv:0807.0041. (IF= 4.691; no C=27)
5. L. M. B. C. Campos & F. J. P. Lau (2009) "On active noise reduction in a cylindrical duct with flow", International Journal of Acoustics and Vibration, volume 14, pages 150-162. (IF= 0.386)
6. Joana da Rocha, A. Suleman and F. J. P. Lau (2011), "Flow-Induced Noise and Vibration in Aircraft Cylindrical Cabins". Journal of Vibration and Acoustics, Vol. 133, No. 5. (doi:10.1115/1.4003935) (IF= 1.268)
7. L.M.B.C. Campos & P. G. T. A. Serrão (2008) "On the acoustic matching of straight, curved and twisted tubes", International Journal of Acoustics and Vibration, Volume 13, pages 100-111. (IF= 0.386)
8. L. M. B. C. Campos, F. S. R. P. Cunha (2012), "On the bifurcations of non-linear sound waves in a relaxing medium", Nonlinear Studies - 19 (3) 201.
9. L. M. B. C. Campos (2011), "On magneto-acoustic-gravity-inertial waves Part I: Generation, propagation, dissipation and radiation". Monthly Notices of the Royal Astronomical Society, Volume 410, pages 717-734, 2011. (DOI: 10.1111/j.1365-2966.2010.17553.x). (IF= 5.521; no C=1)
10. L. M. B. C. Campos & J. M. G. Marques (2011), "On the probability of collision for crossing aircraft". Aircraft Engineering and Aerospace Technology volume 83, number 5, pages 306-314, (doi:10.1108/0002266111159915).

9.4.2 Completed PhD theses

1. Joana da Rocha, "Coupled Structural-Acoustic Analytical Models for the Prediction of Turbulent Boundary-Layer-Induced Noise in Aircraft Cabins", 2010, University of Victoria, Mechanical Engineering. (Supervisors: Afzal Suleman and Fernando Lau).
2. José Lobo do Vale, "Development of Computational and Experimental Models for the Synthesis of Span and Camber Morphing Aircraft Technologies", Doutoramento em Engenharia Aeroespacial, IST, 2012. (supervisors: F. Lau and A. Suleman)
3. Ivo Ferreira, "Enhancing the conceptual design phase of complex engineering systems with an integrated methodology and support tools", Doutoramento no âmbito do Programa MIT-Portugal, Leaders for Technical Industries

9.4.3 Patents and Prototypes or other research outputs

"Sistema de treino de navegação por emulação de ajudas convencionais à navegação", nº de publicação PT 104825 (classificação internacional G09B 9/08), concedida a 2010.04.27. Inventores: Agostinho Rui Alves da Fonseca, Jorge André Marques Frade, José Alexandre Marques Gomes.

9.4.4 Books and book chapters of international circulation

1. L. M. B. C. Campos, "Complex Analysis with Applications to Flows and Fields", CRC Press, 2010, 1029 pages. ISBN: 978-1-4200711-8-4.
2. L. M. B. C. Campos, "Transcendental Representations with applications to Solids and Fluids", CRC Press, 2012, 898 pages. ISBN: 978-1439834312.
3. Gil, P. J. S., 2008. "Spiral curvilinear orthogonal coordinates in the context of astrodynamics", in Advances in Mathematical Problems in Engineering, Aerospace, and Sciences, ed. Seenith Sivasundaram, Cambridge Scientific Publishers, Cambridge, UK, pp. 29-39.
4. L. M. B. C. Campos & J. M. G. Marques "Collision probabilities, aircraft separation and airways safety". In Aeronautics and Astronautics, editor M. Mulder, pages 571-588, Intech. ISBN 978-953-307-473-3.

9.4.5 Conference proceedings

1. L.M.B.C. CAMPOS & A.R.A FONSECA. "Building effects on airport noise", Internoise 2010 Lisboa, 13-16 June 2010.
2. J. VALE, A. SULEMAN & F.J.P. LAU "Development of Camber Morphing Capability in a Telescopic Morphing Wing", EngOpt2010 2nd International Conference On Engineering Optimization, 6 - 9 September 2010, Lisbon.
3. L.M.B.C. CAMPOS & J.M.G. MARQUES. "On maximization of control power in low-speed flight for a flying wing configuration", 27th International Congress of Aeronautical Sciences 19-24 September, Nice.
4. J. Rocha, A. Suleman, and F. Lau, "Prediction of Turbulent Flow-Induced Noise in Aircraft Cabins," Proceedings of the ASME 2010 International Mechanical Engineering Congress and Exposition (IMECE 2010), Vancouver, BC, Canada, November 12-19, 2010.
5. F. Cunha, "Helicopter Operations in Portugal", American Helicopter Society 67th Annual Forum, Virginia Beach, VA, May 3-5, 2011.
6. S. Shankaran and A. C. Marta, Robust Optimization for Aerodynamic Problems using Polynomial Chaos and Adjoints. GT2012-69580, ASME Turbo Expo 2012, Copenhagen, Denmark, June 2012.
7. E. Costa, P. Serrão, A. Ribeiro, V.. Infante, Dynamical Analysis of Portuguese Guitar Strings, , ICEM15, 15th International Conference on Experimental Mechanics
8. L.M.B.C. CAMPOS "On Alfvén waves in the solar wind". Joint European and National Meeting in Astronomy, September 6-10, Lisbon.
9. L.M.B.C. Campos & P.G.T.A. Serrão, "On the discrete and continuous spectrum of waves in a sheared and swirling flows". 16th European Conference on Mathematics for Industry, July 26-30, Wuppertal.
10. J. M. G. S. Oliveira, P. J. S. Gil, "Propagation of sound in ducts with elliptical cross-section and lined walls", 39th International Congress and Exposition on Noise Control Engineering: Inter-Noise 2010, 10-13 June 2010, Lisbon. (no C=2)

9.4.6 New materials, devices, products and processes

1. Construction of a Mini-UAV, a quad-rotor with multiple degrees of freedom obtained from the rotation of two rotors in two different axis, 2011, F. Cunha.
2. Monochord: test set up for guitar strings dynamical analysis, 2012, P. Serrão.
3. One permanent station for data collecting from satellite navigational systems, designated by IST4, placed at Lisboa Airport and used in the following projects: operational evaluation of EGNOS system; and study, development, implementation and operational evaluation of a GBAS system. (A. R. A. Fonseca)
4. Two permanent stations for data collecting from satellite navigational systems, designated by IST6 e IST7, placed at Lisboa Airport and used in the project of study, development, implementation and operational evaluation of a GBAS system (A. R. A. Fonseca)
5. Research Flight Simulator, at Laboratório de Engenharia Aeroespacial, Instituto Superior Técnico.
6. Design of an long endurance electric UAV, with hybrid solar-battery propulsion sistem (A.C. Marta).

9.4.7 Software, computer code and algorithms

1. "Uncertainty quantification in aerospace structures using finite element models, sampling techniques and perturbation methods". (A. C. Marta)
2. "Multidisciplinary and multiobjective optimization framework for aero-acoustic design of wind turbine blades". (A.C. Marta)
3. "High-fidelity RANS adjoint solver for turbomachinery blade design applications". (A.C. Marta)
4. "Robust and reliability-based design optimization methods for multidisciplinary aircraft design". (A.C. Marta, A. Suleman)

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

L.M.B.C. Campos, & W. Schroeder (Guest Editors), "CEAS/AIAA Combustion Noise Workshop", International Journal of Aeroacoustics, Volume 8, pages 1-176, 2008

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

1. L.M.B.C. CAMPOS & P.J.S. Gil "On the trajectory of rockets in the atmosphere", in Progress in Industrial Mathematics at ECMI 2008, ed. Fitt, A.D.; Norbury, J.; Ockendon, H.; Wilson, E., Volume 13, Springer-Verlag, Series Mathematics in Industry, pp. 739-746 (ISBN 978-3-642-12109-8; DOI 10.1007/978-3-642-12110-4).
2. L.M.B.C. CAMPOS & J.M.G. MARQUES "On aircraft response and control during a wake encounter", in Progress in Industrial Mathematics at ECMI 2008, ed. Fitt, A.D.; Norbury, J.; Ockendon, H.; Wilson, E., Volume 13, Springer-Verlag, Series Mathematics in Industry, pp. 747-752 (ISBN 978-3-642-12109-8; DOI 10.1007/978-3-642-12110-4).
3. L.M.B.C. CAMPOS & J.M.G. MARQUES "On alternative safety metrics for the probability of collision between aircraft", in Progress in Industrial Mathematics at ECMI 2008, ed. Fitt, A.D.; Norbury, J.; Ockendon, H.; Wilson, E., Volume 13, Springer-Verlag, Series Mathematics in Industry, pp. 753-758 (ISBN 978-3-642-12109-8; DOI 10.1007/978-3-642-12110-4).

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

1. L. M. B. C. Campos is Contributor to Mathematical Reviews.
2. L. M. B. C. Campos contributed to "Aeroacoustic Research in Europe: the CEAS-ASC report on 2008 highlights". Editor D. Juvé. Section 8.1, page 239. Journal of Sound and Vibration volume 328, pages 213-242.
3. L. M. B. C. Campos contributed to "Aeroacoustic research in Europe: The CEAS-ASC report on 2010 highlights". Editor A.R. Nagy. Section 9.4, page 25, Journal of Sound and Vibration.

9.4.17 Organisation of scientific dissemination activities

1. F. Cunha: Member of the Organizing Committee, 5th International Workshop on System & Concurrent Engineering for Space Applications - SECESA 2012, 17-10-2012, 19-10-2012, (<http://www.congrexprojects.com/12c12>).
2. A. C. Marta: Member of the Organizing Committee of the 2nd LAETA Young Resarchers Meeting, Porto, Portugal,

10-11 April 2012.

3. L. M. B. C. Campos was Chairman of session: "General acoustics", 10th AIAA/CEAS Aeroacoustics Conference, 7-9 June, Stockholm, 2010
4. L. M. B. C. Campos was Chairman of session "Airport Noise", Internoise 2010, 13-16 June, Lisbon., 2010.
5. L. M. B. C. Campos was Member Scientific Advisory Committee (SAC) of Aerodays 2011, Madrid, Sponsored by the European Union, 2011.
6. P. J. S. Gil was presidente of the local organization comitee, 5th International Workshop on Systems & Concurrent Engineering for Space Applications - SECESA 2012, October 17-19, 2012, IST, Lisboa, Portugal.
7. A. C. Marta: session chair of Structural Optimization at the EngOpt 2012 - 3rd International Conference on Engineering Optimization, Rio de Janeiro, Brazil, 1-5 July 2012.
8. A. C. Marta: session chair of Industrial Applications at the EngOpt 2010 - 2nd International Conference on Engineering Optimization, Lisbon, Portugal, 6-9 September 2010.

9.4.18 Research contracts with national or international entities

1. "Uncertainty Quantification in Heat Transfer Turbomachinery Design", sponsored by General Electric - Global Research, USA, 2012. Principal investigator: André Marta. (19.2 k€)
2. "Turbomachinery Aerodynamic Design Tools", General Electric - Global Research, USA. From 15-1-2011 to 31-12-2011. PI: André Marta. (19.2 k€)
3. Developing New Design Optimization tools for GE Aviation Turbine and Compressor Aero Needs General Electric - Global Research, USA from 15-2-2010 to 31-12-2010. PI: André Marta (14.3 k€)

9.4.19 Projects funded in national and international competitive calls

1. NACRE (New Aircraft Concepts Research), funded by European Union, 6th Framework programme, 2nd call, Action Aeronautics, leader: Airbus; partners :see table 0; role: airframe noise shielding and cruise drag minimization.
2. FRIENDCOPTER (Integration of Technologies in support of a passenger and environmentally friendly helicopter), funded by European Union, 6th Framework Programme, 1st call, Action Aeronautics; leader: Eurocopter; partners: see table 0; role of Group: model of helicopter noise and ground effects. (2004-2009)
3. X3-NOISE (Aircraft Noise Network) - Phase III, funded by the European Union, under the 6th Framework programme, 1st call, European Research Area/Aeronautics; leader-SNECMA France; role of Group: Support task 5: Scientific exchanges. (2007-2010)
4. COSMA (Community Oriented Solutions to Minimize aircraft noise annoyance), funded by European Union, 7th Framework Programme, 2nd Call, Aeronautics; leader: EADS Innovation Works; role of Group: models of: (i) propagation in atmospheric turbulence and wind; (ii) effects of ground and obstacles on sound (iii); jet and turbine noise source components for engines.
5. X-NOISE EV (Aircraft Noise Network) - Phase IV, funded by the European Union, 7th Framework Programme, 3rd Call. Leader-SNECMA, France. (2011-2014)
6. Projecto PTDC/FIS/103306/2008 "Análise dinâmica das cordas da guitarra portuguesa e sua interacção com o corpo do instrumento (Dynamical analysis and improvements on the Portuguese guitar strings and string-body interaction)". Projecto leader: CCTAE (PI: Pedro Serrão).
7. "Multidisciplinary Optimization in Aeronautical and Astronautical Design." (Principal investigator in fluid-structure interaction: André Marta) Scientific and technological cooperation between IST (Portugal) and ITA (Brazil) under the FCT/CAPES initiative - 2011/2012.

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The Group is active in 10 areas:

- 1 - The series volume "mathematics and Physics Applied to Science and Technology", published by CRC Press (the 1st volume was published in 2011, the 2nd in 2012, the 3rd will be published in 2014; more to follow).
- 2 - Aeroacoustics: A,B,C,E,F,H,I,J.
- 3 - Adaptive and Morphing Structures: B,C,B,D, K.
- 4 - Dynamics of Atmospheric and Space Flight: A,B,C,G,H.
- 5 -Air Traffic Management: A,G,J.
- 6 - Space Science and Technology: A,F,D.
- 7 - Mathematics: A,E.
- 8 - Flight Testing and Simulation: H,J.
- 9 - Aircraft and Component Design: A, B, C, D, K.
- 10 - Aerodynamics and Propulsion: A, B, D, E.

The Integrated researchers (8) of the group active in each area are indicated as follows:

- A - L.M.B.C. Campos
- B - A. Suleman
- C - F.J.P. Lau
- D - A. Marta
- E - F.S.R.P. Cunha
- F - P.J.S. Gil
- G - J. Marques
- H - A.A.F. Fonseca

and the collaborating members (3)

- I - J.M.G.S. Oliveira
- J - P.G.T.A. Serrão
- K - A. A. Gomes.

The group works on a variety of subjects, with individual members choosing freely their areas of collaboration. Some areas, like aeroacoustics, involve most of the members of the group, that is one of the most productive in publications worldwide, covering many topics. Other areas, like air traffic management are quite specific and involve a small number of members of the group. Some areas are fundamental (mathematical reviews), most applied (aeroacoustics), some industry motivated (propulsion), some experimental (wind tunnel, flight simulator), others practical (flight testing and satellite navigation signal monitoring). There is both concentration (aeroacoustics and flight dynamics) and diversity, both demonstrated in publications and contracts.

The group is divided, without rigid boundaries, into two main streams:

- Aerospace Science and Flight Dynamics, led by L. M. B. C. Campos: aeroacoustics, flight dynamics, space science, ATM, mathematical and physical methods.
- Adaptive Structures and Aircraft design, led by A. Suleman: morphing structures, adaptive materials, multi-disciplinary design optimization.

There are 4 Laboratories:

- 1 - Aerodynamic and aeroacoustics wind tunnel (F. S. R. P. Cunha)
- 2 - 6-degree-of-freedom flight simulator (P. G. T. A. Serrão)
- 3 - Flight Testing (A. A. A. Fonseca)
- 4 - Space Mission planning (P. J. S. Gil)

9.5.2 Objectives of the Research Group

1. In the series: "MATHEMATICS AND PHYSICS APPLIED TO SCIENCE AND TECHNOLOGY", besides the 3 volumes already completed (see section 9.3.1), three new follow-on volumes should appear, about the same size 900-1000 pages.

Volume IV - "Ordinary Differential Equations with applications to Trajectories and Vibrations"

Volume V - "Partial Differential Equations with applications to waves and diffusion"

Volume VI - "Series and Transforms with Applications to Systems and Statistics"

2. Aeroacoustics

- Extensions of the Lighthill's eight-power law of sound intensity to acoustic-vortical waves.
- Sound propagation in temperature gradients in media at rest and sheared flows
- Acoustics of swirling flows downstream of turbines
- Effects of wind on airport noise
- Effects of rough ground on airport noise
- Sound transmission to the interior of room
- Noise of propellers
- Noise of helicopter rotor
- Aerodynamic noise

3. Adaptive and Morphing Structures

- Piezoelectric and adaptive materials
- Aeroelasticity of morphing structures
- Morphing airfoils and control devices
- Morphing of helicopter rotor blades

4. Dynamics of Atmospheric and Space Flight

- Cruise drag minimization of aircraft
- Maximization of control power
- Coupling and decoupling of control modes
- Non-linear airplane stability

- Trajectories of space launchers in the atmosphere
- Optimization of satellite launch trajectories
- Transonic vibrations in satellite payload bays.

5. Air Traffic Management

- Wake vortex separation distance at airports
- Effects of damping in wake vortex response
- Separation between flight trajectories

6. Space Science and Technology

- Rotating, dissipative magneto-hydrodynamics
- Self-gravitating isothermal gas clouds
- Thermodynamics of cosmological models
- Thermal analysis of spacecraft
- Fast transfer orbits to Mars
- Optimal observation orbits

7. Mathematics

- Generalized Bessel differential equation
- Hyperspherical associated Legendre polynomials
- Non-linear population problems related to spread of epidemics

8. Flight and Wind Testing and Simulation

- Testing of partial chevron nozzles
- Qualification of aeroacoustics measuring array.

9. Aircraft and Component Design

- Noise shielding aircraft configuration
- Aircraft inaudible outside airport perimeters
- Cruise-efficient aircraft with low environmental impact
- Multi-disciplinary optimization of wind turbine blades, including aerodynamics, structures, dynamics and acoustics
- Long endurance green UAVs
- Robust and reliability-based design optimization methods

10. Aerodynamics and Propulsion

- Turbulent wall pressure spectra
- Drag of mixing jets
- Aerothermodynamics of atmospheric re-entry
- Physics of hypersonic flight in high-atmosphere (30 to 150 Km)
- Experimental characterization of electric propulsion systems in wind tunnel
- Advanced numerical methods for turbomachinery aerodynamic and aero-thermal blade design using adjoint methods
- Design and testing of green propulsion systems for small UAVs

(RG-50022-1619) Intelligent Systems

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1619

9.1.2 Name of the Research Group in portuguese

Sistemas Inteligentes

9.1.3 Name of the Research Group in English

Intelligent Systems

9.1.4 Keyword(s)

Mechatronic systems

Network distributed systems
Intelligent data modeling and optimization
Systems engineering in the life sciences

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica (IDMEC)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
João Miguel Costa Sousa	Yes	Yes
José Manuel Gutierrez Sá da Costa	No	Yes
Paulo Jorge Coelho Ramalho Oliveira	No	Yes
Paulo José da Costa Branco	No	No
Susana de Almeida Mendes Vinga Martins	No	No
Antonio Eduardo de Barros Ruano	No	No
Joao Manuel Gouveia de Figueiredo	No	No
João Manuel Ferreira Calado	No	No
Miguel Afonso Dias Ayala Botto	No	No
Duarte Pedro Mata de Oliveira Valério	No	No
Jorge Manuel Mateus Martins	No	No
Mário Rui Melício da Conceição	No	No
Susana Margarida da Silva Vieira	No	No
Hugo Miguel Inácio Pousinho	No	No
jose raul carreira azinheira	No	No
Alexandra Bento Moutinho	No	No
Luis Manuel Fernandes Mendonça	No	No
Paulo Jorge Sequeira Gonçalves	No	No
Carlos Batista Carneira	No	No
João Carlos Prata dos Reis	No	No
Rafael Sousa Costa	No	No

9.2.2 List of current PhD students

NAME

Camilo Augusto Rebocho de Jesus Christo

Pedro Miguel Santos Pires

Pedro Daniel Dinis Teodoro

João Miguel Lemos Chasqueira Nabais

Rúben Duarte Magalhães Alves Pereira

Ana Rita Carvalho Domingues

Carlos André Freitas Vasconcelos
Pedro Miguel Baptista Torres
Fernando Paulo Neves da Fonseca Carreira
Nelson António Martins da Costa Batista
Mafalda Maria Morais Seixas
Rui Jorge Ribeiro Laia
Luís André Pereira Fialho
Carla Solange Pires Correia Viveiros
Guilherme Henrique Machado de Matos de Madureira
CRISTIANO LOURENÇO CABRITA
Hamid Reza Khosravani
Elmira Hajimani
João Filipe Pereira Fernandes
András Hartmann

9.2.3 List of other researchers of the Research Group

NAME

Joao Rogerio Caldas Pinto
Carlos Augusto Santos Silva
Ines Tejado Balsera
Mario Antonio da Silva Neves Ramalho
Pedro Jorge Borges Fontes Negrão Beirão
Mário José Gonçalves Cavaco Mendes

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

During 2008 to 2012 the activity of the Intelligent Systems Group (CSI) aimed the interplay of systems and control theory and engineering and health applications, having national and international orientation and seeking cooperation with other research institutes and industry. The research & development activities of the CSI intended three complementary activities; (i) fundamental research, (ii) systems development and applications (iii) transfer of technology to industry.

During this period the research & development activities were organized in three main areas, namely: systems & control; complex systems; and, robotic systems. The research team had in average 20 PhD members and around 10 PhD students during this period. In average during this period two of the PhD members were full-time post-doctoral researchers. 60% of the PhD members are affiliated with IST- University of Lisbon, and the others to University of Algarve, University of Évora and Polytechnics of Lisbon, Castelo Branco and Coimbra. The majority of these members are lectures dedicating only half of their time to research.

The team was supported by two technicians in the development of laboratory prototypes and one administrative secretary.

Within 2008 to 2012 the research and development activities of the team of the Intelligent Systems Group (CSI) in this proposal have been funded by the National Science Foundation (FCT), by other public bodies, by the European Union and by private companies in a total of 2339k€ (1871k€ net), corresponding to an average of 19k€ per PhD (20) per year net. The funding distribution for this period was: LAETA funding 12%, the basic FCT-CSI 16%, the European projects 12%, the FCT projects 33%, other National funding 21%, contracts with national industry 6% and international industry 1%.

9.3.2 Main achievements

The overall research & development achievements of the team of the Intelligent Systems Group in this proposal, during

the period of 2008 to 2012, can be summarized as follows:

Books (7), Chapters in books (29), Publications in international Journals with peer review (122), Publications in national Journals (5), Publications in international conferences (246), Publications in national conferences (37), PhD thesis completed (16), MSc thesis completed (101), Post-Doctoral research programs (14), International projects (16), National projects (28), Organization of scientific events (65), Patents and prototypes (5), Software applications (21), Technical reports and communications (31).

The main contributions to the state of the art of the three main areas of research activity of CSI are summarized as follows:

The area of SYSTEMS & CONTROL focused on the theoretical development and application of new methodologies in: (i) Systems and control in life sciences (nonlinear system identification, nature inspired systems); (ii) Hybrid systems (state estimation, robust control and fault detection in hybrid stochastic systems); (iii) Fractional systems (approximation to fractional derivatives and integrals, modeling and identification of fractional systems, variable order control and quantitative feedback control of fractional systems); (iv) Automation & systems integration (building automation & energy management, industrial communications); (v) Renewable energy systems (solar-photovoltaic systems; ocean waves energy converters; other renewable energies, energy production management, power systems).

The area of COMPLEX SYSTEMS aimed the development and application of new methodologies for: (i) Distributed intelligent optimization of complex systems (modeling, control and optimization of network systems, supply chain systems, logistic processes); (ii) Distributed control based on cooperative behaviour (system design and architecture, traffic management based on multi-agents systems, intelligent transportation systems); (iii) Fault tolerant control in networked control systems (fault-tolerant control methods, fault-tolerant control in NCS based on multi-agents systems); (iv) Data analysis using a combination of soft computing and statistical methods (model selection and validation, evolving in fuzzy modeling, bio-inspired metaheuristics, statistics with imperfect and incomplete data using fuzzy methods).

The area of ROBOTIC SYSTEMS focused on the development and application of new methodologies for: (i) Dynamics and control of rigid-flexible systems (integrated design of rigid-flexible multibody systems, humanoid robots, robotic surgery, biomechatronic devices, hybrid human-machine systems); (ii) Active control of structures (active noise and vibration control, active shape control); (iii) Mobile robots (navigation in dynamic environments, cooperation, service robotics, underwater robots, mobile robot platforms for research and education); (iv) Flight Control (modeling and control of airships, aircraft flight control and automatic landing, flight tests); (v) Machine Vision (visual servoing in rigid flexible systems, medical image processing, robotic intelligent assistance to health, automatic vision for industrial applications, pattern recognition).

The developments and achievements in the areas covered by CSI research were applied in different systems which include, beside others, three tank system, irrigation canals, buildings, photo-voltaic plants, oscillating water column converters, fuel cells, HVAC systems, distributed supply-chains, rolling bearings systems, health care system, logistic processes, energy systems, flexible robot manipulators, multibody mechatronic systems, human body, humanoid robot, ankle foot orthosis, mobile robots, quadrotors, airships, ocean exploration.

Detailed information about developments and application are given in the publications, thesis and other research outputs of the team.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

L. F. Mendonça, J. M. C. Sousa and J. M. G. Sá da Costa, "An architecture for fault detection and isolation based on fuzzy methods". *Expert Systems With Applications*, 36(2): 1092-1104, March 2009. DOI: 10.1016/j.eswa.2007.11.009 (IF = 2.988, C = 14)

C. A. Silva, J. M. C. Sousa, T. A. Runkler and J.M.G. Sá da Costa, "Distributed supply-chain management using ant colony optimization", *European Journal of Operations Research*, 199:349-358, December 2009. DOI: 10.1016/j.ejor.2008.11.021 (IF = 1.627, C = 15)

D. Valério, J. M. G. Sá da Costa, "Variable-order fractional derivatives and their numerical approximations", *Signal Processing*, 91(3):470-483, Mar 2011. DOI: 10.1016/j.sigpro.2010.04.006 (IF = 1.373, C = 12)

P. Flores, M. Machado, Miguel T. Silva, J. M. Martins, "On the continuous contact force models for soft materials in multibody dynamics", *Multibody System Dynamics*, 25: 357-375, 2011. DOI: 10.1007/s11044-010-9237-4 (IF = 1.802, C = 27)

Henriques, T; Cesar, B; Costa Branco, P. J.; "Increasing the efficiency of a portable PEM fuel cell by altering the cathode channel geometry: A numerical and experimental study", *Applied Energy*, 87(4): 1400-1409, April 2010. DOI: 10.1016/j.apenergy.2009.09.001 (IF = 4.781, C = 12)

Batista, P.; Silvestre, C.; Oliveira, P. "Optimal position and velocity navigation filters for autonomous vehicles", *Automatica*, 46(4): 767-774, April 2010. DOI: 10.1016/j.automatica.2010.02.004 (IF = 2.919, C = 11)

Tenazinha, N., and Vinga, S.; "A Survey on Methods for Modeling and Analyzing Integrated Biological Networks", IEEE/ACM Transactions on Computational Biology and Bioinformatics, 8(4):943-958, 2011. DOI: 10.1109/TCBB.2010.117 (IF = 1.616, C = 11)

S. M. Vieira, J. M. C. Sousa, U. Kaymak, "Fuzzy criteria for feature selection", Fuzzy Sets and Systems, 189(1):1-18, February 2012. DOI: 10.1016/j.fss.2011.09.009 (IF = 1.759, C = 6)

J. R. Azinheira, A. Moutinho, E. C. Paiva, "A backstepping controller for path-tracking of an underactuated autonomous airship", International Journal of Robust and Nonlinear Control, 19(4):418-441, March 2009. DOI: 10.1002/rnc.1325 (IF = 1.56, C = 6)

Figueiredo, J., Sá da Costa, J., "A SCADA System for Energy Management in Intelligent Buildings", Energy and Buildings, 49: 85-98, Jun 2012. DOI: 10.1016/j.enbuild.2012.01.041 (IF = 2.386, C = 4)

9.4.2 Completed PhD theses

André Soromenho da Silva Fialho, "Knowledge Discovery in Intensive Care Unit Shock Patients", Supervisors: PhD in Bioengineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisors: João Miguel da Costa Sousa and Stan Finkelstein, Co-Supervisor: Shane Reti, November 2012.

Federico Cismondi, "Preprocessing and Misclassifying Issues in Clinical Data Sets for Prediction and Intervention", PhD in Bioengineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisors: João Miguel da Costa Sousa and Stan Finkelstein, Co-Supervisor: Shane Reti, November 2012.

Maria Sofia Reis de Orey, "Passive Dynamic Walkers and Sensory Systems for Gait Analysis", PhD in Bioengineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: Miguel Silva, Co-Supervisor: Jorge Martins, June 2012.

Paula Luísa Carvalho Goulão Capelo Silva, "Computational Modelling of a Wearable Ankle-Foot Orthosis for Locomotion Analysis and Comfort Evaluation", PhD in Mechanical Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: Miguel Silva, Co-Supervisor: Jorge Martins. June 2012.

Tiago Filipe Ferreira Gonçalves, "Aircraft Control by Visual Servoing", PhD in Aerospace Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: José Raul Azinheira, December 2010.

João Carlos Prata dos Reis, "Estudo e Desenvolvimento de um Elo Inteligente para Robôs Manipuladores", PhD in Mechanical Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: J.M.G. Sá da Costa, November 2010.

Susana Margarida da Silva Vieira, "Soft Computing Techniques Applied to Feature Selection", PhD in Mechanical Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: João M. C. Sousa, Instituto Superior Técnico, March 2010.

Mário José Gonçalves Cavaco Mendes. Multi-agent Approach to Fault Tolerant Control Systems. PhD in Mechanical Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisors: José Sá da Costa and João Calado, December 2008.

Marco Martins Morgado. Advanced Ultra Short Baseline Inertial Navigation Systems. PhD in Electrical and Computer Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: Paulo Oliveira, Co-supervisor: Carlos Silvestre, 2011.

Alex Alcocer Penas. Positioning and Navigation Systems for Robotic Underwater Vehicles. PhD in Electrical and Computer Engineering, Universidade Técnica de Lisboa, Instituto Superior Técnico. Supervisor: Paulo Oliveira, Co-supervisor: Carlos Silvestre, January 2010.

9.4.3 Patents and Prototypes or other research outputs

N.C. Batista, R. Melício, J.P.S. Catalão, "Vertical axis turbine blades with adjustable form", Patent US 2012/0163976 A1, June 2012.

João Figueiredo, Prototype for a Fresnel solar concentrator with 1 motorized mirror (property Catedra BES-Renewable Energies/ University Évora) 2012

Paulo Melo, Jorge Martins, Miguel T. Silva, EME - A four channel Electronic Functional Electric Stimulator to promote biomechanical functions in disabled persons, 2011.

José Borges, Artur Borges, João Campos e Manuel Nina, "Distribution system of energy for charging batteries of electric vehicles." National Patent n. 104395, INPI - Instituto Nacional da Propriedade Intelectual, February 2009.

Figueiredo, J., Alves, A., Belchiorinho, C., Roberto, M.; "Automatic obstacle for sportive use" National patent n. 104 043, INPI - Instituto Português de Propriedade Industrial; April 2008.

Carreira, F. et. al., "Autonomous vehicle to transport safely hospital meals", National Patent n. 104113, June 2009.

9.4.4 Books and book chapters of international circulation

Duarte Valério, José M. G. Sá da Costa; "An Introduction to Fractional Control", IET, 2013, ISBN: 978-1-84919-545-4.

C. Borgelt, M. Gil, J. M. C. Sousa, M. Verleysen (eds.), "Towards Advanced Data Analysis by Combining Soft Computing and Statistics", Studies in Fuzziness and Soft Computing, Vol. 285, Springer, 2013, ISBN: 978-3-642-30278-7.

A. E. Ruano, A. Várkonyi-Kóczy, (eds.), "New Advances in Intelligent Signal Processing", Studies in Computational Intelligence, Vol. 371, Springer, 2011. ISBN: 978-3-642-11738-1

J. P. Carvalho, D. Dubois, U. Kaymak and J. M. C. Sousa (eds.), "Proceedings of 2009 International Fuzzy Systems Association World Congress and 2009 European Society for Fuzzy Logic and Technology Conference". Lisbon, Portugal, 20th - 24th July, 2009.

Figueiredo, J., "Knowledge Transfer between University and Industry: Development of a Vision Measuring System", in Mechanical Engineering Education; Mechanical Engineering and Solid Mechanics Series, Ed. P. Davim, ISTE Ltd and John WILEY, London, 2012, pp. 131-163; ISBN 978-1-84821-381-4.

O. Türksen, S.M. Vieira, J.F.A. Madeira, A.L. Custódio, A. Apaydin and J.M.C. Sousa. "Comparison of multi-objective algorithms applied to feature selection", in Towards Advanced Data Analysis by Combining Soft Computing and Statistics, Edited by Christian Borgelt, Maria Ángeles Gil, João M.C. Sousa, and Michel Verleysen, Vol. 285, pp. 359-375, Springer 2013.

S. Saraiva, R. Melício, J.C.O Matias, J.P.S. Catalão, C. Cabrita, "Simulation and experimental results for a photovoltaic system formed by monocrystalline solar modules", in: Technological Innovation for Value Creation, Eds. L.M. Camarinha-Matos, E. Shahamatnia, G. Nunes, SPRINGER, Heidelberg, Germany, ISBN: 978-3-642-28254-6, pp. 329-336, February 2012.

S.A. Hartmann, P.C. Pinto, T.A. Runkler and J.M.C. Sousa, "Social insect societies for the optimization of dynamic NP-hard problems", In Yang Xiao, editor, Bio-Inspired Computing and Networking, pp. 43-67, CRC Press, March 2011.

S. M. Vieira, J.M.C. Sousa, U. Kaymak, "Ant Feature Selection Using Fuzzy Decision Functions", in Fuzzy Optimization - Recent Advances and Applications, Editors Weldon A. Lodwick and Janusz Kacprzyk, pp343-364, Springer-Verlag Studies in Fuzziness and Soft Computing, Volume 254, 2010, DOI: 10.1007/978-3-642-13935-2

João M.G. Figueiredo, "PLC based Structure for Management and Control of Distributed Energy Production Units", in Luiz Affonso Guedes (Ed.), ISBN 978-953-7619-63-3, Programmable Logic Controller, INTECH, Croatia, pp. 161-170, Jan. 2010

9.4.5 Conference proceedings

P. Pinto, A. Naegele, M. Dejori, T. Runkler, J. M. C. Sousa; "Learning of Bayesian Networks by a Local Discovery Ant Colony Algorithm", Proc. of IEEE Congress on Evolutionary Computation, pp. 2741-2748, Hong Kong, Jun 1-06, 2008, DOI: 10.1109/CEC.2008.4631166.

G. Vinagre, D. Valério, P. Beirão, J. Sá da Costa; "Laboratory software for the three-tank benchmark system: from PID to multi-agent fault-tolerant fractional control", Proc. 4th World Conference on Educational Sciences (WCES), pp. 1919-1923, Barcelona, Spain, Feb. 2-5, 2012, DOI: 10.1016/j.sbspro.2012.05.403.

Ferreira, P.; Ruano, A.; "Evolutionary Multiobjective Neural Network Models Identification: Evolving Task-Optimised Models", Proc. 6th IEEE International Symposium on Intelligent Signal Processing, pp. 21-53, Budapest, Hungary, Aug. 26-28, 2009. DOI: 10.1007/978-3-642-11739-8_2.

Carreira, F., Christo, C., Valério, D., Ramalho, M., Carneira, C., Calado, J. and Oliveira, P., "2D PCA-based Localization for Mobile Robots in Unstructured Environments". Proc. da IEEE/RSJ International Conference on Intelligent Robots and Systems, IROS 2012, Vilamoura, Portugal, pp. 3867-3868, 7-12 Oct. 2012, DOI: 10.1109/IROS.2012.6386272.

J. Nabais, M. Ayala Botto, "Flexible Discrete Time State Space Model for Canal Pools", Lecture Notes in Electrical Engineering, 2013, volume 174, Part 4, pp. 159-171, 2013 (Paper selected from 8th International Conference on Informatics in Control, Automation and Robotics, ICINCO 2011, Noordwijkerhout, The Netherlands, July 28-31, 2011).

J. Pinheiro, J.M. Lemos, and Susana Vinga; "Nonlinear MPC of HIV-1 infection with periodic inputs", Proc. 50th IEEE Conference on Decision and Control and European Control Conference (CDC-ECC 2011), pp. 65-70, Orlando, USA, 12-15 Dec. 2011, DOI: 10.1109/CDC.2011.6160806.

Melicio, R.; Mendes, V.; Catalao, J.; "Two-level and Multilevel Converters for Wind Energy Systems: A Comparative Study", Proc. 13th International Power Electronics and Motion Control Conference, pp. 1682-1687, Poznan, Poland, Sept 1-3, 2008, DOI: 10.1109/EPEPEMC.2008.4635509

R. Pereira, J. M. C. Sousa, S. M. Vieira, S. R. Reti and S. N. Finkelstein, "Modified Sequential Forward Selection Applied to Predicting Septic Shock Outcome", Proc. 6th International Conference on Soft Methods in Probability and Statistics (SMPS) 2012, pp. 2507 - 2512, Konstanz, Germany, October 2012. DOI: 10.1007/978-3-642-33042-1_50.

V. Esteves, J. M. C. Sousa, C. Silva, A. Póvoa, M. Gomes, "SCant-Design: Closed Loop Supply Chain Design using Ant Colony Optimization", Proc. of the 2012 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE), pp. 2078-3085, Brisbane, Australia, June 10-15, 2012, DOI: 10.1109/CEC.2012.6252944.

P. J. S. Gonçalves, J. M. C. Sousa; J. R. Caldas Pinto, "Evolving inverse fuzzy models for uncalibrated visual servoing in 3D workspace", in Proc. 2009 International Fuzzy Systems Association World Congress and 2009 European Society for Fuzzy Logic and Technology Conference, IFSA-EUSFLAT 2009, pp. 1857-1862, Lisbon, Portugal, July 2009.

9.4.6 New materials, devices, products and processes

João Figueiredo, Prototype for a Fresnel solar concentrator with one motorized mirror (property Catedra BES-Renewable Energies/ University of Evora).

Jorge Martins, José Sá da Costa, A multiprocessor VMEbus based real time infrastructure, controlling various single and multilink lightweight flexible manipulator arms actuated with joint motors and piezoelectric actuators.

F. Carreira, C. Christo, D. Valerio, M. Ramalho, C. Carreira, J. M. F. Calado, and P. Oliveira, Robot prototype for ceiling based navigation.

<http://www.dem.ist.utl.pt/~carreira/Products/Robot%20prototype%20for%20ceiling%20based%20navigation.htm>

Jorge Martins, José Sá da Costa, A gait lab for human motion capture through fast image acquisition and force platforms

F. Carreira, C. Carreira, J. M. F. Calado, and P. Oliveira, Prototype for robot localization from RGBD data.

<http://www.dem.ist.utl.pt/~carreira/Products/Prototype%20for%20robot%20localization%20from%20RGBD%20data.htm>

9.4.7 Software, computer code and algorithms

MECANISMO - A computational tool, linking Matlab, Maple and Ansys, and allowing for integrated controller design, multibody dynamics simulation, structural analysis and optimization.

Multibody model based on natural coordinated to model human locomotion through prescribed kinematics.

Multibody model for real time control, simulation and animation of a humanoid robot.

Real time communication interface between an experimental humanoid robot and Matlab/Simulink.

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

J.R. Caldas Pinto, Automation Techniques (In Portuguese), ETEP, ISBN: 978-972-8480-26-4, 3rd Edition, March 2010.

Miguel Ayala Botto, "Control Systems" (In Portuguese), Editor: Associação dos Estudantes do Instituto Superior Técnico, Feb. 2009.

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

9.4.17 Organisation of scientific dissemination activities

António Ruano, 3rd IFAC International Conference on Intelligent Control and Automation Science, Chengdu, China, 2-4 September 2012 (General Co-Chair).

João M. C. Sousa, 13th Int. Fuzzy Systems Association World Congress and 6th European Society for Fuzzy Logic and Technology Conference, IFSA-EUSFLAT 2009, 20-24 July 2009, Lisbon, Portugal. (General Chair)

Carlos Carneira, RoboCup Junior 2012: 18-24 June, Mexico City, Mexico (General Chair).

António Ruano, 2nd Ambient Computing Colloquium in Engineering and Education, University of Algarve, Faro, Portugal, 2-3 May 2011, Conference Chair.

José Sa da Costa, 35th Annual Conf. of the IEEE Industrial Electronics Society IECON'09, 3-5 November, Porto, Portugal, 2009. (Co-chair in Control)

João M. C. Sousa, Publicity Co-Chair of 2010 IEEE World Congress on Computational Intelligence, WCCI 2010, 18-23 July, Barcelona, Spain

Carlos Carneira, Special Sessions Co-Chair of ETFA'2011, the 16th IEEE International Conference on Emerging Technologies and Factory Automation, September 5-9, Toulouse, France.

António Ruano, 5th IEEE International Workshop on Soft Computing Applications (SOFA 2012), Szeged, Hungary, 23-25 August 2012 (Steering Committee Member).

Carlos Carneira, Tutorials Co-Chair of INDIN'2011, the IEEE 9th International Conference on Industrial Informatics, Caparica, Lisbon, Portugal, 26-29 July 2011.

J. M. F. Calado, Member of the Organizing Committee of the 6th Portuguese-Mozambican Engineering Congress - CLME2011, Maputo, Mozambique, August 29 - September 2, 2011.

9.4.18 Research contracts with national or international entities

2010 - FINERTEC Energia S.A, Remote Autonomous Systems

2010- GALP ENERGIA S. A, Smart Galp

2010- Wave Energy Centre - Development of wave energy converters

2010 - Zeugma - Development of Mechatronics devices ankle implants

2006 - 2009, P4TMS - Platform for Transport Management Services, GLS-Grupo Luís Simões and Brisa, Portugal

2007 - 2008, Simulation of the production system of the sand paper factory, INDASA, Aveiro, Portugal.

2006 - 2008, Optimized production planning of a pharmaceutical company, JABA, Lisbon

2009-2012, Human motion imitation using closed-loop control techniques for use in video and real walking humanoid robots, EUREKA - EUROSTARS

2007-2009, AURORA - Autonomous Unmanned Remote Monitoring Robotic Airship project GRICES/CNPQ SISROB, with CTI, Campinas, Brazil

2006 - 2008, PETER - Portuguese-Spanish Experimental Park of Renewable Energies, PIC Interreg IIIA SP6.E53/03, Univ. de Évora, Univ. Extremadura

9.4.19 Projects funded in national and international competitive calls

2012-2013 - European Clearing House for Open Robotics Development (ECHORD), EU-funded project

2006-2009, PEGASE - "helicoPter and aEronef naviGation Airborne System Experimentations", EU, Aeronautics and space specific targeted project, contract AST5-CT-2006-030839

2006-2008, FPIAA project of the Atlas experiment of the Large Hadron Collider in CERN.

2012-2014 - Decision Support System for Preventing ICU Readmissions, FCT, PTDC/EMS-SIS/3220/2012, PI. J. M. C. Sousa (IC4U)

2010-2013, Robot Assisted and Ultrasound-Guided Navigation for Hip Resurfacing Arthroplasty, FCT, PTDC/EME-CRO/099333/2008. PI: J. Martins (HipRob)

2010-2013, Systems Redesign to Improve the Survival of Critically Ill Patients Using Data Based Modeling, PTDC/SEN-ENR/100063/2008. PI: J. M. C. Sousa (ID2care)

2011-2013, Physical Human-Robot Interaction for Fault-Tolerant Surgical Applications, FCT, PTDC/EME-CRO/114571/2009. PI: J. Sá da Costa, (SurgRob)

2010-2012, Decentralized and reconfigurable control of distributed water systems in channels, FCT, PTDC/EEA-CRO/102102/2008. PI: Miguel Ayala Botto (AQUANET)

2007 - 2009, Integrated Design of Lightweight Robot Manipulators with Kinematical Redundancy and Smart Links, FCT, PTDC/EME-CRO/72085/2006. PI: J. Sá da Costa, (FLEXIBLE)

2007 - 2009, Fractional Modelling, Identification and Control: Theoretical Developments and Applications, FCT, PTDC/EME-CRO/70341/2006. PI: D. Valério, (FRACTIONAL).

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The Intelligent Systems research group (CSI) for the period 2015/2020 will be formed by 21 PhD faculty and research members. The team will be supported by two technicians in the development of laboratory prototypes and one administrative secretary.

The Group will have four main research areas, namely: Mechatronic Systems, Network Distributed Systems, Intelligent Data Modelling and Optimization, and Systems Engineering in the Life Sciences. Each member of the group belongs mainly to one area and collaborates in another one. Therefore, each research area has a critical mass of around 10 members.

João M. C. Sousa (full professor) will head the group and will coordinate the research activities in Intelligent Data Modelling and Optimization. Jorge Martins (assistant professor), who will be the co-coordinator of the group, will assist the head of the group in the interface with IDMEC/LAETA and will coordinate the interface of the research group with industry and society in general.

José M. G. Sá da Costa (full professor) will coordinate the research activities in Network Distributed Systems.

Paulo Oliveira (associate professor) will coordinate the research activities in Mechatronic Systems.

Susana Vinga (associated researcher) will coordinate the research activities in Systems Engineering in the Life Sciences.

Camilo Christo (engineer) will be the responsible for the laboratories.

The Scientific Council of CSI is composed by all the integrated members. The Scientific Council meets twice a year. One of the meetings, which will be annual, will be a scientific workshop, where all the integrated members will present and discuss the most recent research results. Further, the group will have an annual meeting with the Advisory Committee that will evaluate the ongoing research and will propose possible new research lines for the Group.

The coordination team comprises the coordinator, the co-coordinator and the four coordinators of the four main research areas. This team will deal with the admission or withdrawal of members, and with the financial and activity reports. The coordination team meets every three months or whenever necessary.

The Intelligent Systems research group will coordinate the thematic research line of Engineering Systems in Key Enabling Technologies, which includes the topics: Systems Design in Mechatronics; Automation and Systems Integration; Intelligent Data-Based Modelling, Control and Optimization; and cross cut most research groups of LAETA.

CSI beyond leading the research line of Engineering Systems, will collaborate in the thematic research lines of: Energy (energy efficiency and energy storage); Transports technology (Electrical mobility, logistics and enhanced automation); Aeronautics (performance, stability, flight simulation and flight tests); Biomechanics (biomechatronics); and will lead the subtopic of Systems Engineering in the Life Sciences included in the Future and Emerging Technologies.

9.5.2 Objectives of the Research Group

The main objectives of the Intelligent Systems Group for the period 2015/2020 will be focused on research & development activities in four complementary activities; (i) fundamental research, (ii) systems development and applications, (iii) transfer of technology to industry, and (iv) post-graduate education (supervision of PhD and MSc students). The research activity of CSI for this period will aim the multidisciplinary interplay of systems and control theory and engineering applications.

The area of MECHATRONIC SYSTEMS will focus on a new design paradigm that intertwines the mechanical, electronic and computer engineering domains, under a common systemic framework, resulting in synergistic solutions to tackle complex challenges of societal relevance. Development of fleets of robotic vehicles, in ground, aerial, and marine scenarios, cooperative and hybrid human/robotic manipulation systems, medical and service robots and artificial muscle technology for biomedical applications are examples of developments to be pursued. This research will target the advancement of robotics technology in three focal areas: development of targeted interventional procedures, which require the merging of medical imaging algorithms with high precision robotic devices; development of assistive technical aids for aged persons or for the impaired; and development of guidance, positioning and navigation systems using new platforms and challenging scenarios. These challenges will be addressed using new sensors, actuators, embedded systems, and adaptive materials, leading to revolutionary mechatronic solutions.

The area of NETWORKED DISTRIBUTED SYSTEMS will address the concept of networked systems applicable to engineering systems in order to enhance its performance and security. Many infrastructures and service systems of the present day society can naturally be described as networks of a huge number of simple interacting units. The availability of reliable and fast communication solutions motivated the decentralized management of spatially distributed systems. This research area will focus its expertise in the research in: smart energy management, including

renewables, power systems, urban transport, buildings and energy storage; distributed optimization of supply chains and supply networks using advanced bio-inspired algorithms; fault tolerant control in networked control systems based on multi-agents systems; control of multi-robot networks; distributed control applied to agriculture and industry; distributed estimation for sensor networks; network systems in biology.

The area of INTELLIGENT DATA MODELLING AND OPTIMIZATION will address the development of models and decision support systems based on intelligent methodologies. As data gets big and complex, there is a need for multidisciplinary approaches to transform data into knowledge. This transformation allows analysis, learning, knowledge extraction and modeling in very different domains, including engineering, biomedicine or environment. This research area involves the design of intelligent models and algorithms and the development of decision making models to form classifiers personalized diagnosis, patient treatment systems, and process modeling systems.

The area of SYSTEMS ENGINEERING IN LIFE SCIENCES will focus on the identification of bio-systems, systems biology, systems medicine and translational medicine. The rise of genomics and accumulation of heterogeneous amounts of biological and biomedical data is driving the emergence of a new systems based approach to life sciences. The foremost question in Systems Biology and Medicine is how to explain the complexity of living organisms by integrating multiscale data from physiological experiments. Systems engineering is playing a central role in unraveling this structure and understanding the behavior of complex organisms, with direct applications to interpreting physiological systems through a mathematical and computational perspective.

(RG-50022-1620) Manufacturing and Industrial Management

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1620

9.1.2 Name of the Research Group in portuguese

Tecnologia Mecânica e Gestão Industrial

9.1.3 Name of the Research Group in English

Manufacturing and Industrial Management

9.1.4 Keyword(s)

Mechanical Processing of Materials
Thermal Processing of Materials
Polymer and Ceramic Material Processing
Lean, Agile and Life Cycle Approaches to Manufactu

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica (IDMEC)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
PAULO ANTÓNIO FIRME MARTINS	Yes	Yes
Barbara Perry Pereira Alves Gouveia Almeida	No	No

Maria Beatriz Cipriano de Jesus Silva	No	No
Carlos Manuel Alves da Silva	No	No
Elsa Maria Pires Henriques	No	Yes
Ines da Fonseca Pestana Ascenso Pires	No	No
Inês Ribeiro	No	No
Jorge Manuel da Conceicao Rodrigues	No	No
Luís Manuel Mendonça Alves	No	No
Maria Luisa Coutinho Gomes Almeida Quintino	No	Yes
Paulo Miguel Nogueira Pecas	No	No
PEDRO ALEXANDRE RODRIGUES CARVALHO ROSA	No	No
Rui Manuel dos Santos Oliveira Baptista	No	No

9.2.2 List of current PhD students

NAME

Miguel Dias Castilho

Ivo Manuel Ferreira de Bragança

Gabriel Rosa Ribeiro

Miguel Maltez José

Filipe Miguel Ferrreira Nascimento

Catarina Isabel Silva Vidal

Michael Donauer

João Miguel Ventura Fernandes

Jean-Loup Loyer

José Manuel Ferreira Gaspar

Malliaros Ioannis

9.2.3 List of other researchers of the Research Group

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

The Manufacturing and Industrial Management group has a long research pedigree that goes back to the 1980's with the first developments of computer models and experimental setups for metal forming processes. In the past 30 years the group evolved in order to cover a broader range of topics comprising mechanical and thermal processing of materials, polymer and ceramic material processing and lean, agile and life cycle approaches to manufacturing. During the period 2008/2012 the activities of the group were focused on fundamental research, experimentation, training and transfer of technology. Research was aimed at developing new manufacturing processes, applying existing manufacturing processes to new materials and identifying new level of understanding on selected manufacturing processes that allowed predicting process behavior across the useful range of operating conditions. More than 80% of the group's overall funding (with an average value of 36k€ per group member, per year) was obtained from services and research projects in collaboration with companies.

During the period 2008/2012 the research group consisted of 14 PhD faculty members, 1 PhD facility engineer and 1 technician with backgrounds in manufacturing, material science and industrial management but with production engineering as their common interest. The senior researchers of the group in the aforementioned period were Paulo Martins (professor and head of the group) and Luisa Coutinho (associate professor with habilitation).

Paulo Martins has a PhD in mechanical engineering and is a member of CIRP (The International Academy for Production Engineering), of the advisory board of ICTP (The International Conference of Technology of Plasticity) and belongs to the editorial board of several international journals. He is co-author of more than 150 scientific papers in international journals with peer reviewing, 5 books and has an h-index 19 (Scopus). He was awarded with 2 national

and 6 international prizes during the period 2008/2012. Luisa Coutinho has a PhD in mechanical engineering and is director of EWF (European Welding Federation) and IIW (International Institute of Welding) and member of the editorial board of several international journals. She is co-author of more than 50 scientific papers in international journals with peer reviewing, 5 books and has an h-index 11 (Scopus).

Nowadays, the group may be defined as a small team of mature-aged and high-level qualified researchers with complementary skills. Five of the group members are less than 40 years, five other members are aged between 40 and 50 years and the remaining five members are aged above 50 years. The publication record of the group during the period 2008/2012 accounted for 1.5 papers in peer reviewed international journals per group member, per year, an average number of citations of the 10 most cited papers equal to 20 and an average impact factor of the publications where those papers were published equal to 2.4. Most of the researchers of the group have strong links with the international research community both in terms of collaborative research work, publications (with 25% of international affiliations in the 10 most cited papers) and visiting scholarships.

The total area of laboratories is approximately equal to 430 m² and includes a main unit equipped with metal forming, machining and welding equipment (with 260 m²) and smaller, specialized units, equipped with testing machines, metrology equipment, additive manufacturing and micro-manufacturing systems. Part of the facilities are equipped with commercial equipment that was purchased by the group but there is also a significant amount of equipment that was designed, fabricated and instrumented by the research group members that are more engaged in the development of tool systems and machine-tools.

9.3.2 Main achievements

The activities during the period 2008/2012 were focused in mechanical and thermal processing of materials, polymer and ceramic material processing and lean, agile and life cycle approaches to manufacturing.

In the area of mechanical processing of materials the main achievements were: (i) the development of innovative tube forming and joining process to fabricate metallic liners for composite overwrapped pressure vessels utilized in aerospace applications and to attach tubes to sheets and tubes to tubes made from metals or polymers, (ii) the development of a theoretical framework for the deformation mechanics and formability limits of single point incremental forming of metallic and polymeric sheets, (iii) the design and fabrication of electromagnetic testing machines that replicate the kinematics of real machine tools, (iv) the development of theoretical and experimental studies aimed at demonstrating the influence of fracture toughness in metal cutting and blanking, (v) the design and fabrication of an innovative pin-on-disc machine to determine friction in freshly formed surfaces under different gas protective shields, (vi) the development and fabrication of prototype machines for micro-EDM and micro-ECM.

In the area of thermal processing of materials the main achievements were: (i) software for cost calculation in welding and for analyzing the ergonomics in manual welding, (ii) development of prototype tools for friction stir channeling, surfacing and for the production of multi-graded materials, (iii) patents for ultrasonic welding of copper and aluminum cables, (iv) definition of the operating procedures for laser welding of shape memory alloys, high strength steels and dissimilar joining, (v) femtosecond laser cutting and dissimilar joining of shape memory alloys and (vi) the development of a neural network based control system for CMT welding.

In the area of polymer and ceramic materials processing focus was placed on thermoplastic and elastomer processing and additive manufacturing. In case of thermoplastic processing the main achievement was the development of a new concept for automotive intercoolers in cooperation with a Portuguese industrial company. In case of elastomers the main achievements were: (i) the experimental characterization of elastomers under different deformation modes, (ii) the development of two numerical codes to determine the material parameters for different hyperelastic models and curve fitting analysis, and to evaluate the numerical stability domain (according to Drucker's criterion) for the hyperelastic models and (iii) the numerical study of the crimping and sealing conditions in automotive intercoolers. In case of additive manufacturing the activity was focused in biofabrication and the main achievements were: (i) the development and characterization of calcium phosphate materials for the 3DP powder based system, (ii) the optimization of the 3DP fabrication, (iii) the development and implementation of a methodology to characterize physical, morphological and mechanically the synthetic bone implants obtained by 3DP and (iv) the optimization of post printing steps.

In the area of lean, agile and life cycle approaches to manufacturing the main achievements were: (i) the development of comprehensive life cycle engineering approaches based on process-based models to support design decisions and technology evaluation, (ii) the development of techniques to map the heterogeneity and variability of performances on Human-Centred assembly systems, (iii) the contribution to understanding innovation processes in a low-tech SME, acting in traditional sectors of the economy, (iv) the development of a framework to analyze and improve complex engineering processes and (v) the development of optimization algorithms for problems arising in industry and services. Other achievements are summarized as follows: Books (9), Chapters in books (16), International Journals with peer review (114) and Patents (16).

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

1. Silva M. B., Skjoedt M., Atkins A. G., Bay N. and Martins P. A. F., "Single Point Incremental Forming & Formability/Failure Diagrams", *Journal of Strain Analysis for Engineering Design*, 43, 15-36, 2008. (IF= 0.881, C= 32) doi: 10.1243/03093247JSA340
2. Martins P. A. F., Bay N., Skjoedt M. and Silva M. B., "Theory of Single Point Incremental Forming", *CIRP Annals* -

Manufacturing Technology, 57, 247-252, 2008. (IF= 2.251, C= 28) doi:10.1016/j.cirp.2008.03.047

3. Ribeiro, I., Peças P., Silva A. and Henriques E., "Life cycle engineering methodology applied to material selection, a fender case study", Journal of Cleaner Production, 16, 887-1899, 2008. (IF= 3.398, C = 23) doi:10.1016/j.jclepro.2008.01.002

4. Peças P. and Henriques E., "Electrical discharge machining using simple and powder-mixed dielectric: The effect of the electrode area in the surface roughness and topography", Journal of Materials Processing Technology, 200, 250-258, 2008. (IF=1.953, C=21) doi:10.1016/j.jmatprotec.2007.09.051

5. Silva M. B., Skjoedt M., Martins P. A. F. and Bay N., "Revisiting the Fundamentals of Single Point Incremental Forming by Means of Membrane Analysis", International Journal of Machine Tools & Manufacture, 48, 73-83, 2008. (IF= 2.262, C= 20) doi:10.1016/j.ijmactools.2007.07.004

6. Peças P. and Henriques E., "Effect of the powder concentration and dielectric flow in the surface morphology in electrical discharge machining with powder-mixed dielectric (PMD-EDM)", International Journal of Advanced Manufacturing Technology, 37, 1120-1132, 2008. (IF= 1.205, C=18) doi:10.1007/s00170-007-1061-5

7. Miranda R. M., Lopes G., Quintino L., Rodrigues J. P. and Williams S., "Rapid prototyping with high power fiber lasers", Materials and Design, 29 2072-2075, 2008. (IF= 2.913, C=17) doi:10.1016/j.matdes.2008.03.030

8. Nascimento F., Santos T., Vilaça P., Miranda R. M. and Quintino L., "Microstructural modification and ductility enhancement of surfaces modified by FSP in aluminium alloys", Materials Science and Engineering A, 506, 16-22, 2009. (IF= 2.108, C= 16) doi:10.1016/j.msea.2009.01.008

9. Ratinho T., Henriques E., "The role of science parts and business incubators in converging countries: Evidence from Portugal", Technovation, 30, 278-290, 2010 (IF= 3.177, C= 13) <http://dx.doi.org/10.1016/j.technovation.2009.09.002>

10. Peças P., Ribeiro I., Folgado R. and Henriques E., "A Life Cycle Engineering model for technology selection: a case study on plastic injection moulds for low production volumes", Journal of Cleaner Production, 17, 846-856, 2009. (IF= 3.398, C=12) doi:10.1016/j.jclepro.2009.01.001

9.4.2 Completed PhD theses

1. Maria Beatriz Cipriano de Jesus Silva, Single Point Incremental Forming, IST, 2008.

2. Telmo Jorge Gomes dos Santos, Ensaios Não Destrutivos por Correntes Induzidas: Desenvolvimento e Aplicação à Soldadura por Fricção Linear, IST, 2009.

3. José Pedro Ovelheiro Marques de Sousa, From Digital to Material: Rethinking Cork in Architecture Through the use of CAD/CAM Technologies, IST, 2010

4. Chris Valentin Nielsen, 3D Modeling and Testing of Contact Problems in Resistance Welding, DTU, Denmark, 2012.

5. Valentino Anok Melo Cristino, Revisiting the Calibration of Friction in Metal, Cutting, IST, 2012.

6. Valentin Josef Richter-Trummer, Residual Stress Effects and Damage Tolerance Behaviour of Integral Light Weight Structures Manufactured by FSW and HSM, FEUP, 2012.

7. Carla Marisa Valente Salsinha Pepe, A Framework to Analyse and Improve Engineering Processes, IST, 2012.

8. Marco Alexandre de Oliveira Leite, Techno Economic Evaluation in Materials Selection for Multiple Parts Under OEM-Tier, IST, 2012.

9. Pedro Domingos Belo Carmona Marques, Creativity in Product Development, A Contribution to the Understanding of Front-end Design, IST, 2012.

10. Inês Esteves Ribeiro, Comprehensive Life Cycle Framework Integrating Part and Tool Design, IST, 2012.

9.4.3 Patents and Prototypes or other research outputs

1. Método e aparelho para a determinação do coeficiente de atrito em interfaces de contacto com superfícies recém-geradas Inventors: P. A. F. Martins, P. A. R. Rosa and V. A. M. Cristino. Owners: IST PT 103935, 2008

2. Máquina de ensaios de Hopkinson de impulsão electromagnética Inventors: C. M. A. Silva, P. A. F. Martins e P. A. R. Rosa Owners: IST PT 104167, 2008

3. Método de Ensaio Não Destrutivo Baseado em Variante de Sonda de Correntes Induzidas Inventors: P. Vilaça, T. Santos and M. Piedade Owners: IST PT 104089, 2008

4. Novo Sistema de Apertos para Equipar Máquina de Escovaria Inventors: P. Mota and P. Peças Owners: IST PT 104035, 2008.

5. Mola para pendurar roupa Inventors: Possolo C., Peças P., Silva A. Owners: IST PT 1012, 2008

6. Ferramenta não consumível modular ajustável e refrigerável para soldadura e processamento por fricção linear Inventors: Vilaça P., Santos T. Owners: IST PT 104072, 2008

7. Plastic Deformation Technological Process for Production of Thin Wall Revolution Shells from Tubular Billets Inventors: L. M. Alves, P. A. F. Martins, T. C. D. Pardal, P. J. C. Almeida and N. M. P. A. Valverde Owners: OMNIDEA PCT/PT2009/000007, 2009

8. Processo tecnológico para o fabrico de reservatórios de parede fina a partir de pré-formas tubulares e suas aplicações Inventors: L. M. M. Alves, T. C. D. Pardal and P. A. F. Martins Owners: IST e OMNIDEA PT 104159, 2010
9. Actuador linear simultâneo de relutância magnética Inventors: C. M. A. Silva, P. A. F. Martins, P. A. R. Rosa and A. J. R. Bastos Owners: IST PT 104165, 2010
10. Processo de cravação de alavanca para travão Inventors: L. M. Alves, E. J. Dias and P. A. F. Martins Owners: MCG PT 105554, 2012.

9.4.4 Books and book chapters of international circulation

1. Ribeiro I., Peças P., Henriques E., Life Cycle Engineering Applied to Material Selection, Environmental Impact Assessments, Nova Publishers, 2009.
2. Rosa P.A.R., Alves L.M., Martins P.A.F., Experimental and Numerical Modeling of Tube End-Forming Processes, Finite Element Method in Manufacturing Processes, ISTE - WILEY, 2010.
3. Peças P., Henriques E., Ribeiro I., Integrated approach to product and process design based on Life Cycle Engineering, Handbook of Research on Trends in Product Design and Development: Technological & Organizational Perspectives, Business Science Reference, IGI Global, 2010.
4. Silva M.B., Bay N., Martins P.A.F., Single-Point Incremental Forming, Sustainable Manufacturing, ISTE - WILEY, 2010.
5. Gandra J., Miranda R.M., Vilaça P., Production of FGMs by Friction Stir Processing - A preliminary study, Lambert Academic Publishing, 2012.
6. Vilaça P., Thomas W., State-of-the-art in FSW Technology. Chapter of book: Structural Connections for Lightweight Metallic Structures. Structural Connections for Lightweight Metallic Structures (Series: Advanced Structured Materials, Volume 8, 1-32). Springer, 2012
7. Quintino L., Laser Welding of Structural Aluminium, Chapter of book: Structural Connections for Lightweight Metallic Structures. Structural Connections for Lightweight Metallic Structures, Chapter 1, Series: Advanced Structured Materials, Volume 8, Springer, 2012.
8. Alves L.M., Martins P.A.F., Joining Sheets to Tubular Profiles by Tube Forming in Computational Methods for Optimizing Manufacturing Technology: Models and Techniques, IGI-Global, 2012.
9. Silva M.B., Marques T., Martins P.A.F., Single Point Incremental Forming of Polymers in Mechatronics and Manufacturing Engineering - Research & Development, Woodhead Publishing, 2012.
10. Alves L.M., Santana P., Fernandes N., Martins P.A.F., Manufacturing Seamless Reservoirs by Tube Forming: Finite Element Modelling and Experimentation in Statistical and Computational Technique in Manufacturing, Springer-Verlag, 2012.

9.4.5 Conference proceedings

1. Santos T., Vilaça P., Quintino L., Santos J., Miranda R.M., Advanced eddy current probes: developments and applications to FSpW and composite materials, 64rd IIW Annual Assembly & International Conference, Istanbul, Turkey, 2010.
2. Cunha P.F., Event Management within networks of SMEs for complex products manufacturing, 60th CIRP General Assembly, Pisa, Italy, 2010.
3. Bragança I.M.F., Rosa P.A.R., Dias F.J.C.M., Alves L.L., Study of micro-EDM plasmas, 64th Annual Gaseous Electronics Conference, Salt Lake City, USA, 2011.
4. Quintino L., Miranda R.M., Fernandes I., Impact of Qualification of Personnel in Manufacturing Industry, 64th IIW Annual Assembly & International Conference, Chennai, India, 2011.
5. Nielsen C., Martins P.A.F., Zhang W., Bay N., Mechanical Contact Experiments and Simulations, ICTP 2011 -10th International Conference on Technology of Plasticity, Aachen, Germany, 2011
6. Miranda R.M., Oliveira J.P., Braz Fernandes F.M., Quintino L., Similar Laser Welding of Shape Memory Alloys: Microstructural and Mechanical Characterization, 65th IIW Annual Assembly & International Conference, Denver, July 2012.
7. Assunção E., Miranda R.M., Vieira M.T., Quintino L., Laser Butt Welding of NiTi to Stainless Steel and Ti6Al4V, 65th IIW Annual Assembly & International Conference, Denver, July 2012.
8. Peças P., Ribeiro I., Henriques E. Life Cycle Engineering: Modeling the Life Cycle Performance, 5th International Conference on Polymers and Moulds Innovations, Ghent, Belgium, 2012.
9. Silva C.M.A., Rosa P.A.R., Martins P.A.F., Compression Testing using a Cam-Driven Electromagnetic Machine, ICHSF 2012 - 5rd. International Conference on High Speed Forming, Dortmund, Germany, 2012.
10. Centeno G., Silva M.B., Vallellano C., Martins P.A.F., Manufacturing of Sheet Metal Flanged Parts using Multi-stage SPIF, Metal Forming 2012, 14th International Conference on Metal Forming, Kraków, Poland 2012.

9.4.6 New materials, devices, products and processes

1. Silva C. M. A., Rosa P. A. R. and Martins P. A. F., Electromagnetic compressive split Hopkinson bar, 2009.
2. Martins, P.A.F, Kwiatkowski L., Franzen V., Tekkaya A. E., Kleiner M., Single point incremental forming of polymers , 2009.
3. Cristino V. A. M., Rosa P. A. R. and Martins P. A. F., A new pin-on-disc testing machine for calibration of friction in metal cutting, 2009.
4. Santos T., Vilaça P., Santos J., Quintino L., Innovative eddy current probe for micro defects, 2009.
5. Alves L. M. and Martins P. A. F., Flexible forming tool concept for producing crankshafts, 2011.
6. Silva C. M. A., Rosa P. A. R. and Martins P. A. F., Electromagnetic cam driven compression testing equipment, 2012.
7. Bragança I. M. F., Ribeiro G. R., Rosa P. A. R., Martins P. A. F., A prototype machine for micro-EDM, 2012.
8. Ribeiro G. R., Bragança I. M. F., Rosa P. A. R., Martins P. A. F., A prototype machine for micro-ECM, 2012.
9. Alves L. M., Santana P., Fernandes N., Martins P. A. F., New technology for fabricating metallic liners for composite overwrapped pressure vessels utilized in aerospace applications, 2012
10. Alves L. M., Martins P. A. F., Tube branching by asymmetric compression beading, 2012

9.4.7 Software, computer code and algorithms

1. Nielsen C. V., Zhang W., Martins P. A. F. - SORPAS 3D - Commercial finite element program distributed by SWANTEC ApS for performing the all-in-one three-dimensional simulation of resistance welding, weld strength tests and failure modes.
2. Nielsen C. V., Fernandes L., Martins P. A. F. - All hexahedral meshing and remeshing computer program for finite element applications
3. Rodrigues J.M.C., Gouveia B.P.P.A. - RUBBER - A curve-fitting program to determine the parameters of hyperelastic models for rubber-like materials.
4. Rodrigues J.M.C., Gouveia B.P.P.A. - STABILITY - A computer program to evaluate the numerical stability domain of hyperelastic models. Interfaces for ANSYS and ABAQUS to assess the numerical stability of the numerical model.
5. Quintino L. - Software for cost calculation in welding and for analyzing the ergonomics in manual welding

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

1. Rodrigues J.M.C, Martins P.A.F., Tecnologia da Deformação Plástica: Aplicações Industriais, Escolar Editora, 2010.
2. Rodrigues J.M.C, Martins P.A.F., Tecnologia da Deformação Plástica: Fundamentos Teóricos, Escolar Editora, 2010.
3. Gouveia B.P.P.A., Rodrigues J.M.C, Martins P.A.F., Tecnologia da Deformação Plástica: Exercícios resolvidos, Escolar Editora, 2011.
4. Rosa P., Processos Substractivos; in Manual de Micromanufactura, Edições Centimfe. ISBN: 978-989-95964-3-6, 2008.
5. Peças, P., Henriques, E., Ribeiro, I., A Roadmap to the Implementation of Life Cycle Approaches in the Design of Plastic Injection Moulds - Roadmap para a Implementação de Abordagens de Ciclo de Vida no Projecto de Moldes de Injeção de Plástico, Edições Centimfe, ISBN: 978-989-95964-2-9, 2008.
6. Henriques, E., New Business Models for the Tooling Industry - Novos Modelos de Negócio para a Indústria de Moldes e Ferramentas, Edições Centimfe, ISBN: 978-989-95964-1-2, 2008.

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

1. Button S. T., Schaeffer L., Martins P. A. F. (Editors) , Special issue of the International Journal of Mechatronics and Manufacturing Systems, Vol. 1, Nos. 2/3, 2008.
2. Martins, P.A.F., Special issue of the International Journal of Surface Science and Engineering Tribology in Manufacturing Processes, Inderscience, 2010.

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

9.4.17 Organisation of scientific dissemination activities

1. Martins P.A.F., Member of the organizing committee of the 28th SENAFOR - International forging conference, Porto Alegre, Brazil, 2008.
2. Quintino L., Member of the organizing committee of the symposium on innovation in production technologies, Lisbon, Portugal, 2008.
3. Baptista R. M. S. O., Member of the organizing committee of the EUREKA Umbrella PRO-FACTORY Symposium, Marinha Grande, Portugal, 2008.
4. Martins P.A.F., Member of the organizing committee of the 29th SENAFOR - International Forging Conference, Porto Alegre, Brazil, 2009.
5. Martins P. A. F., Member of the organizing committee of the VII Euromech solids mechanics conference, Lisboa, Portugal, 2009.
6. Martins P.A.F., Member of the organizing committee of the 30th SENAFOR - International forging conference, Porto Alegre, Brazil, 2010.
7. Rosa P.A.R. and Martins P. A. F., Member of the organizing committee of the 13th CIRP Conference on modelling of machining operations (CIRP CMMO), Sintra, Portugal, 2011
8. Martins P.A.F., Member of the organizing committee of the 31th SENAFOR - International forging conference, Porto Alegre, Brazil, 2011.
9. Martins P.A.F., Member of the organizing committee of the 32th SENAFOR - International forging conference, Porto Alegre, Brazil, 2012.
10. Quintino L., Member of the organizing committee of the Eurojoin 2012, Pula, Croatia, 2012.

9.4.18 Research contracts with national or international entities

1. ROLLSROYCE (UK) - A framework for improvement of complex Product Development processes, 2011
2. IBEROLEFF (PT) - Decision making methodology on HMI innovative processes, 2011
3. INCOMPOL S.A. (PT) - Aeronautics line - components and sub-assemblies, 2011
4. OMNIDEA (PT) - Nosing of thin-walled reservoirs using a die for automotive and aerospace applications, 2008-2012
5. OMNIDEA (PT) - Differential pressure regulator micro-valve, 2011
6. SIEMENS (PT) - Application of FSW to the multi-stage production process of electrical transformers, 2011-2012
7. DELPHI (PT) - Development of aluminium cables weldability by ultrasonic welding technology, 2011
8. IBEROLEFF (PT) - Influence of variability in the performance of assembly systems, 2011
9. CARRS TECHNOLOGY SOLUTIONS (UK) - Disc laser welding and cladding, 2011
10. Portuguese National Standards (PT): CT 182 - Execução de estruturas metálicas, at CEN/TC 135 - Execution of Steel Structures and Aluminium Structures, 2011

9.4.19 Projects funded in national and international competitive calls

1. MAGNETICTUBEJOINT, 234 k€ (ADI), QREN5486
2. MC GRAÇA, 176 k€ (ADI)
3. EURO TOOLING21, 134 k€ (European Community)

4. OMNIDEA, 115 k€ (ESA)
5. INTERCOOLER AR-ÁGUA, 105 k€ (ADI) 2009/5723-QREN
6. PRODUTECH-PSI, 68 k€ (ADI) QREN849
7. AEROINSPECT, 67 k€ (ADI) FCOMP-01-0202-FEDER-011518
8. TOOLINGEDGE, 66 k€ (ADI) FCOMP-01-0202-FEDER-013856
9. MAGGUN, 48 k€ (EXERCITO PORTUGUES)
10. SMART INTERIORS, 12 K€

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The Manufacturing and Industrial Management research group for the period 2015/2020 is expected to be formed by 12 PhD faculty members, 1 PhD facility engineer and 1 technician.

Paulo Martins (professor of manufacturing) will head the group and simultaneously coordinate the research activities in mechanical processing of materials (forming and cutting technologies).

Luisa Coutinho (associate professor with habilitation) will coordinate the research activities in thermal processing of materials (welding and joining technologies).

Jorge Rodrigues (associate professor) will coordinate the research activities in polymer and ceramic materials processing (thermoplastics and elastomer processing and additive manufacturing).

Elsa Henriques (associate professor) will coordinate the research activities in lean, agile and life cycle approaches to manufacturing.

Rui Baptista (assistant professor) will coordinate the interface of the research group with the industry.

Luis Alves (assistant professor) will be the responsible for the laboratory infrastructure, which comprises a wide variety of laboratory equipment and facilities for storing tooling systems, raw materials and other parts or supplies.

Pedro Rosa (assistant professor) will be the responsible for the interface of the research group with the faculty machine shop, which provides manufacturing/fabricating services to group members in technologies not available at the laboratory infrastructure of the Manufacturing and Industrial Management research group.

Beatriz Silva (assistant professor) and Bárbara Gouveia (assistant professor) will assist the head of the group in the interface with IDMEC/LAETA and the mechanical engineering department, respectively.

9.5.2 Objectives of the Research Group

The objectives of the group for the period 2015/2020 will be focused on research, education and development.

Research will be centred on the development of new manufacturing processes, on the application of existing manufacturing processes to new materials and on the identification of new levels of understanding for manufacturing processes by means of theoretical and experimental methods and procedures. The emphasis in education will be focused on training of MSc and PhD students in manufacturing and industrial management. Applied research and engineering services will continue to play a significant role in the overall objectives of the group.

a) Mechanical and Thermal Processing of Materials

The area of mechanical processing of materials will be focused (i) on thermo-electro-mechanical modelling of manufacturing processes, (ii) on formability in bulk and sheet forming of metals and polymers, (iii) on incremental sheet and sheet-bulk forming of metals and polymers, (iv) on tube forming and joining, (v) on electromagnetic forming, joining and cutting, (vi) on the interaction between plastic flow, friction and ductile fracture in metal cutting, (vii) on the mechanical characterization of materials at high loading rates and temperature and (viii) on micro-fabrication. Major partners will be the Technical University of Denmark, the Technical University of Dortmund (Germany), the Universities of São Paulo and Rio Grande do Sul (Brazil) and the industrial partners MCG (Portugal) and Swantec (Denmark).

The area of thermal processing of materials will be focused (i) on friction stir applications, (ii) on micro processing of materials and (iii) on advanced non-destructive testing techniques. Bi-lateral collaboration with the European Welding Federation and other Portuguese research groups will potentiate partnerships in European and national research projects in the areas of (i) laser processing of materials, (ii) friction stir welding, (iii) arc welding, (iv) welding materials with primers and (v) phased array applications in advanced materials.

b) Polymer, Ceramic and Composite Material Processing

The area of polymer processing will be focused (i) on consultancy and engineering services to manufacturers of automotive components and (ii) on the influence of temperature in the visco-hyperelastic behaviour of elastomers. The area of additive manufacturing will be focused (i) on the evaluation and processing of AM materials, (ii) on the fabrication of synthetic bone tissue engineering implants using powder based systems in ceramics and biopolymers, (iii) on the fabrication of metal implants by laser sintering processes, (iv) on the mechanical characterization of ceramic and biopolymers bone implants, (v) on the biomechanical and fluid flow analysis of synthetic bone substitutes by means

of finite elements and (vi) on the interaction between bone implants and tissues. Some of these activities will be carried out in collaboration with the University of Würzburg (Germany) and manufacturers of medical devices.

c) Lean, Agile and Life Cycle Approaches to Manufacturing

This area will be focused (i) on the development of tools and procedures for the implementation of lean and agile principles in the design, development and reengineering of industrial products and production systems, (ii) on the development of robust life cycle engineering models to support the selection of materials and fabrication processes, (iii) on the development of methodologies towards the design improvement of eco-efficient manufacturing systems and (iv) on the contribution to better support TCO strategies: understanding maintenance requirements of complex systems based on the analysis of historical data. This area will continue to strengthen collaboration with the Portuguese tooling industry, the department of design methods of Rolls Royce and the MIT research groups in engineering design processes.

(RG-50022-1622) Mechanical Design

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1622

9.1.2 Name of the Research Group in portuguese

Projecto Mecânico

9.1.3 Name of the Research Group in English

Mechanical Design

9.1.4 Keyword(s)

Optimal Design

Multibody Dynamics

Multiscale Modeling

Materials Characterization

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica (IDMEC)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
Helder Carrico Rodrigues	Yes	Yes
André Rui Dantas Carvalho	No	No
António Manuel Relógio Ribeiro	No	No
Aurélio Lima Araújo	No	No
Carlos Alberto Mota Soares	No	No
Cristóvão Manuel Mota Soares	No	No

Filipa Andreia de Matos Moleiro	No	No
Heitor Lobato Girão Pina	No	No
Joao Evangelista Barradas Cardoso	No	No
Joao Manuel Pereira Dias	No	No
Arlindo José de Pinho Figueiredo e Silva	No	No
Joaquim Infante Barbosa	No	No
Jorge Alberto Cadete Ambrosio	No	Yes
Jose Mateus Simoes Moita	No	No
José Arnaldo Pereira Leite Miranda Guedes	No	No
José Firmino Aguilár Madeira	No	No
José Leonel Monteiro Fernandes	No	No
José Viriato Araújo dos Santos	No	No
João Carlos Eloi de Jesus Pombo	No	No
João Filipe de Almeida Milho	No	No
João Orlando Marques Gameiro Folgado	No	No
Luis Filipe Galvão dos Reis	No	No
Luis Manuel Guerra Silva Rosa	No	Yes
Luís Alberto Gonçalves de Sousa	No	No
Jose Jorge Lopes Da Cruz Fernandes	No	No
Manuel Afonso da Fonte	No	No
Manuel Frederico Oom Seabra Pereira	No	No
Manuel José Moreira Freitas	No	No
Maria Alexandra Sousa Rodrigues	No	No
Maria Amélia Ramos Loja	No	No
Maria Emilia da Encarnacao Rosa	No	No
Maria de Fátima Reis Vaz	No	No
Miguel Antonio Lopes de Matos Neves	No	No
Miguel Pedro Tavares da Silva	No	No
NUNO MIGUEL ROSA PEREIRA SILVESTRE	No	No
nuno manuel mendes maia	No	No
Paulo Rui Alves Fernandes	No	No
Pedro Miguel Gomes Abrunhosa Amaral	No	No
Ricardo António Lamberto Duarte Cláudio	No	No
Ricardo Miguel Gomes Simões Baptista	No	No
Rosa Maria Marquito Marat Mendes	No	No
Rui Pedro Chedas de Sampaio	No	No
Virginia Isabel Monteiro Nabais Infante	No	No

9.2.2 List of current PhD students

NAME

Frederico Canas de Matos e Oliveira Ribeiro

Paula Cristina do Rosário Fernandes

Luís Miguel Francisco Santos

Lina Maria Correia Espinha
Miguel Monteiro Maia Machado
Matija Husic
Ndilokelwa Fernandes Luis
Vítor José da Silva carvalho
Teresa Sofia Marques Mesquita
Afonso Manuel da Costa de Sousa Leite
Hugo Filipe Dinis Policarpo
Paulo Emanuel Luzio de Melo
Sérgio Miguel Barroso Gonçalves
Tiago Alexandre Narciso da Silva
Yoann Eras Lage
Pedro Cabaço Antunes
DARIO GONCALO RIBEIRO SILVA
Pedro Miguel Ferreira Duarte
Carlos Nuno Fernandes Simões
João Paulo de Carvalho Ribeiro Lopes
Elcin Aleixo Calado
Marta Ribeiro Barroso Dias
Ângela Vanessa Chan
Carlos Miguel Fernandes Quental
Nelson da Silva Ribeiro
Diogo Moreira Campos Ferreira de Almeida
Daniel Simões Lopes
Nuno Guitian Pinheiro Fernandes Oliveira
Lígia Margarida Jorge de Figueiredo
Catarina Isabel Silva Vidal
João Luís Jorge Simões Pedro
Bruno Alexandre Rodrigues Simões Soares
Vitor Manuel Rodrigues Anes
Sérgio Pereira dos Santos
Ricardo José Fontes Portal
Georgios Koronis
Irene Cristina Pereira Silva Carvalho
Jakub Jacek Kwapisz
Gabriela Baptista Vasconcelos
Inês Barros Ferreira da Costa
Nuno Miguel Pereira dos Anjos Valverde

9.2.3 List of other researchers of the Research Group

NAME

Luis Manuel Varejao de Oliveira Faria
Paulo Jorge Pires Moita

Anibal Jorge de Jesus Valido
Antonio Freitas Melao Barros
Marta Isabel Pimenta Verdete da Silva Carvalho
José Eugénio Semedo Garção
Marco Alexandre de Oliveira Leite
Bin Li

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

The Mechanical Design Group of LAETA is a research group hosted by IDMEC and the Department of Mechanical Engineering of Instituto Superior Técnico, University of Lisbon. It has 43 senior researchers (25 University Profs, 11 Polytechnic Profs, 5 retired Profs and 2 full time researchers) and 41 PhD students that are dedicated to do research and development work on mechanical design, advanced computational mechanics, biomechanics, experimental mechanics and advanced material characterization and processing.

The group was formed in 1978 organized around the development of models for computational mechanics, experimental mechanics and its application in the context of the design of structural and mechanical components. From there the group expanded its scientific expertise, through a strong international collaboration and participation in the relevant international scientific forums, and lead the Portuguese research efforts in the development of new mechanical design areas e.g. structural and multidisciplinary optimization, multibody dynamics, micro and nano mechanics and homogenization models, biomechanics and mechanobiology, smart structures, structural health monitoring.

The total number of researchers (43) includes a group of fourteen (14) researchers that will join IDMEC in January 2014 (ex-ICEMS laboratory). This group of researchers has a strong expertise on experimental mechanics, conceptual design, material science and rapid prototyping, adding important scientific knowledge and development experience on these essential areas.

The group develops theoretical and applied research in three major (focal) R&D areas, characterized by its main research topics:

Simulation and Design of Mechanical Systems: Structural dynamics, multibody system dynamics, vehicle dynamics, railway dynamics, crashworthiness and impact, accident reconstruction, injury biomechanics. Vibration and noise control, transmissibility and damping. Biomechanics of human movement and design of medical devices.

Modelling and Optimization of Structures and Materials: Optimal design, multidisciplinary optimization, multiscale modelling of cellular and composite materials, optimization of materials microstructure, modelling and simulation of nanomaterials, tissue biomechanics and mechanobiology, biomimetics. Applications on vibration control, structural damping, structural identification, damage detection and characterization, smart structures, optimal design of advanced composites, laminates and piezo materials, design of medical devices, namely prostheses and scaffolds for tissue engineering.

Structural Materials and Advanced Characterization: Characterization of cellular materials, composite materials, natural and bio-materials. Testing and evaluation of materials performance, analysis of fracture, fatigue behaviour under multiaxial loading and high-temperature applications. Evaluation of environmental degradation of biomaterials. Life cycle assessment of components and structures. Rapid prototyping.

9.3.2 Main achievements

In terms of scientific indicators the overall research achievements of the group during 2008-2012 (29 integrated members) can be summarized as follows: books edition (33), Chapters in books and other related publications (30), Publications in international journals with peer review (235), Communications in international conferences (479), and in national conferences (94), PhD theses completed (24), MSc theses completed (139).

In terms of financing and during this period the group got a total financing (competitive financing, not considering the LAETA associate laboratory funding) close to 4.4 million euros. This gives a yearly average of 28K€ per integrated PhD researcher (in 2012). Complementing this amount the group received a LAETA associate laboratory funding close to 1.5 million, i.e. for each euro of seed money the group raised three euros.

In scientific conference organization are significant the following meetings:

Major congresses: 8th World Congress of Structural and Multidisciplinary Optimization, 2009 (420 participants); 7th EUROMECH Solid Mechanics Conference, 2009 (600); ENGOPT2010 (370); European Society of Biomechanics Congress, 2012 (800).

Thematic meetings: Int Conf on Structural Eng Dynamics, 2009 (180) and 2011 (140); Scientific Workshop "Microscale Modeling and Mechanobiology", 2011 (60); International Conference on Railway Technology: Research, Development and Maintenance, 2012 (210); ECCOMAS- International Conference On Tissue Engineering 2009 (90) and 2011 (80 participants); EUROMECH Colloquium Biomechanics of Human Motion. New Frontiers of Multibody, Techniques for

Clinical Applications, 2011 (95) etc.

In terms of research work, the following achievements can be underlined:

Development of multibody dynamics, vibration and optimization models for furthering transport vehicles technology on crash worthiness, passive-active safety, and energy efficiency.

Development of hierarchical/multiscale optimal design methodologies for the design of advanced composite laminates, integrating the design of the structure and its material.

Development of multibody dynamics models for the simulation and reconstruction of vehicles accidents. These models have been widely used to support law court decisions and resolve insurance claims.

Development of a multiscale model to simulate the bone adaption process applied to the design of medical devices namely prostheses and scaffolds for tissue engineering.

Development of an active ankle-foot orthosis, to support people with locomotion pathologies such as drop foot (1^o place prize "Prémio Ser Capaz - Inovação e Tecnologia", Associação Salvador, 2011)

Characterization of electro-mechanical properties of materials and structures by inverse identification techniques and optimization of the location of piezoelectric actuators and sensors on hybrid adaptive structures.

Modelling of viscoelastic laminated sandwich structures with development of new finite element models for hybrid active-passive laminated sandwich structures.

Computational material design of ferroelectric materials microstructure with the objective of optimize the material macro level piezo-properties

Development of force identification techniques based on the concept of transmissibility;

Development of vibration attenuation mechanical components using cork composite materials.

Group members on international societies executive committees:

C Mota Soares, IACM Honorary Fellow ; Fellow ECCOMAS; 2009 Distinguished Ibero - American Person in Mechanical Engineering; President of APMTAC, National Delegate to NMP UE program.

M Seabra Pereira, National Delegate to Transport Program UE

J Ambrosio, P Fernandes, H Rodrigues are in the executive boards of EUROMECH, ESB and ISSMO respectively.

Group members are chief editors of international scientific journals:

J. Ambrósio - Multibody System Dynamics, Springer.

J. Pombo - International Journal of Railway Technology, Saxe-Coburg Pbl.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

1. K.P. Jayachandran, J.M. Guedes, H.C. Rodrigues, Piezoelectricity enhancement in ferroelectric ceramics due to orientation, Applied Physics Letters, 92 (23), pp.232901-232901-3, 2008 (DOI: 10.1063/1.2940215)
2. A.L. Araújo, P. Martins, C.M. Mota Soares, C.A. Mota Soares, J. Herskovits, Damping Optimization of Viscoelastic Laminated Sandwich Composite Structures, Structural and Multidisciplinary Optimization, 39 (6), pp.569-579, 2009 (DOI: 10.1007/s00158-009-0390-4)
3. A.L. Araújo, C.M. Mota Soares, J. Herskovits, P. Pedersen, Estimation of Piezoelastic and Viscoelastic Properties in Laminated Structures, Composite Structures, 87 (2), pp.168-174, 2009 (DOI: 10.1016/j.compstruct.2008.05.009)
4. P. Coelho, P.R. Fernandes, H.C. Rodrigues, J.B. Cardoso e J.M. Guedes, Numerical Modeling of Bone Tissue Adaptation - A Hierarchical Approach for Bone Apparent Density and Trabecular Structure, Journal of Biomechanics, 42(7), pp.830-837, 2009 (DOI: 10.1016/j.jbiomech.2009.01.020)
5. J.A. Madeira, H.L. Pina, H. Rodrigues, GA topology optimization using random keys for tree encoding of structures, Structural and Multidisciplinary Optimization, 40 (1-6), pp.227-240, Jan 2010 (DOI: 10.1007/s00158-008-0353-1)
6. P. Flores, M. Machado, M.T. Silva, J.M. Martins, On the Continuous Contact Force Models for Soft Materials in Multibody Dynamics, Multibody System Dynamics, 25 (3), pp.357-375, 2011 (DOI: 10.1007/s11044-010-9237-4)
7. N.M.M. Maia, R.A.B. Almeida, A.P.V. Urgueira, R.P.C. Sampaio, Damage Detection and Quantification using Transmissibility, Mechanical Systems and Signal Processing, 25(7), pp. 2475-2483, 2011 (DOI: 10.1016/j.ymsp.2011.04.002)
8. J. Pombo, J. Ambrósio, M. Pereira, R. Lewis, R. Dwyer-Joyce, C. Ariaudo and N. Kuka, Development of a Wear Prediction Tool for Steel Railway Wheels Using Three Alternative Wear Functions, Wear, 271 (1-2), pp. 238-245, 2011 (DOI: 10.1016/j.wear.2010.10.072)
9. M. Carvalho, J. Ambrosio, P. Eberhard, Identification of Validated Multibody Vehicle Models for Crash Analysis Using a Hybrid Optimization Procedure, Structural and Multidisciplinary Optimization, 44(1), pp.85-97, 2011 (DOI: 10.1007/s00158-010-0590-y)
10. J. Pombo, J. Ambrosio, Multiple Pantograph Interaction With Catenaries in High-Speed Trains , Journal of Computational and Nonlinear Dynamics, 7 (4), 2012 (DOI: 10.1115/1.4006734)

9.4.2 Completed PhD theses

1. Henrique Rodrigues Boralho dos Santos, Development of Adaptive Shell Finite Element Model, PhD in Mechanical Engineering, UTL/IST, 2008

2. Ricardo Garcia Lage, *Análise de Estruturas Laminadas Adaptativas Por Elementos Finitos Mistos*, PhD in Mechanical Engineering, UTL/IST, 2008
3. Rui Miguel Barreiros Ruben, *Projeto Ótimo de Próteses da Articulação da Anca*, PhD in Mechanical Engineering, UTL/IST, 2009
4. Filipa Andreia de Matos Moleiro, *Mixed Least-Squares Finite Element Models for Analysis of Multilayered Composite Plates*, PhD in Aerospace Engineering, UTL/IST, 2009
5. Marta Isabel Pimenta Verdete da Silva Carvalho, *Development of optimal multibody vehicle models for crash analysis*, PhD in Mechanical Engineering, UTL/IST, 2009
6. Pedro Samuel Gonçalves Coelho, *Modelos Hierárquicos para a Análise e Síntese de Estruturas e Materiais com aplicações à Remodelação Óssea*, PhD in Mechanical Engineering, FCT-UNL, 2010
7. Paulo Jorge Pires Moita, *Optimização da Resposta Dinâmica de Sistemas Mecânicos ao Choque incluindo Domínio de Tempo variável*, PhD in Mechanical Engineering, UTL/IST, 2011
8. Luis Frederico Grases Silva Rauter, *Pantograph-catenary interaction using flexible multibody dynamics methodology*, PhD in Mechanical Engineering, UTL/IST, 2011
9. Fernando da Conceição Batista, *Caracterização Dinâmica de Juntas Aparafusadas*, PhD in Mechanical Engineering, UTL/IST, 2012
10. Maria Sofia Reis d'Orey, *Passive Dynamic Walkers and Sensory Systems for Gait Analysis*, PhD in Biomedical Engineering, UTL/IST, 2012

9.4.3 Patents and Prototypes or other research outputs

1. Atenuador de vibrações axiais multicamada, Inventors: Miguel Neves; Alexandre Fernandes; Ricardo Borralho; Hugo Policarpo; Pedro Ferreira Jorge; Jorge Fonseca; Arlindo Silva, Owner: Instituto Superior Técnico, Patent of Nacional Invention N^o 103969, 2009

9.4.4 Books and book chapters of international circulation

1. J.V. Araújo dos Santos, N.M.M. Maia, C.M. Mota Soares, C.A. Mota Soares, "Structural Damage Identification: A Survey", in B.H.V. Topping, M. Papadrakakis (Editors), *Trends in Computational Structures Technology*, Saxe-Coburg Publications, Stirlingshire, UK, Chapter 1, pp 1-24, 2008 (doi:10.4203/csets.19.1)
2. J. Ambrósio, J. Pombo, F. Rauter, M. Pereira, "A Memory Based Communication in the Co-Simulation of Multibody and Finite Element Codes for Pantograph-Catenary Interaction Simulation", in C.L. Bottasso (Ed.), *Multibody Dynamics, Computational Methods in Applied Sciences*, Vol. 12, Springer, pp.231-252, 2008 (DOI: 10.1007/978-1-4020-8829-2_12)
3. J. Ambrósio and P. Eberhard (Eds.), *Advanced Design of Mechanical Systems: From Analysis to Optimization*, CISM International Centre for Mechanical Sciences, Volume 511, Springer-Verlag, Wien, Austria, ISBN: 978-3-211-99460-3, 2009
4. P.R. Fernandes, R.B. Ruben and J. Folgado "Bone Implant Design Using Optimization Methods", in A. Oechsner and W. Ahmed (Eds.), *Biomechanics of Hard Tissues: Modelling - Testing - Materials*, WILEY-VCH, ISBN: 9783527317189, pp. 267-296, 2010
5. A.L. Araújo, C.M. Mota Soares, C.A. Mota Soares, "Inverse Techniques for the Characterisation of Mechanical and Piezoelectric Properties on Composite and Adaptive Structures: A Survey", in *Computational Technology Reviews*, ISBN: 978-1-874672-50-0, Vol. 2, pp.103-123, 2010 (doi:10.4203/ctr.2.5)
6. J.N. Reddy, R.A. Arciniega, F. Moleiro, "Finite element analysis of composite plates and shells", in R. Blockley, W. Shyy (Editors), *Encyclopedia of Aerospace Engineering*, John Wiley & Sons, UK, Vol. 3, Part 15, pp. 1683-1702, ISBN: 978-0-470-68665-2, 2010 (DOI: 10.1002/9780470686652.eae161)
7. P.R. Fernandes and P. Bártolo (Eds.), "Advances on Modeling in Tissue Engineering", Springer, ISBN: 978-94-007-1253-9, 2011 (DOI: 10.1007/978-94-007-1254-6)
8. H.C. Rodrigues, P.G. Coelho, P.R. Fernandes, "Multiscale Modelling of Bone Tissue - Remodelling and Application to Scaffold Design", in P.R. Fernandes and P. Bártolo (Eds.), *Advances on Modeling in Tissue Engineering, Computational Methods in Applied Sciences*, Volume 20, Springer, ISBN: 978-94-007-1253-9, pp.15 -33, 2011 (DOI: 10.1007/978-94-007-1254-6_2)
9. J. Ambrósio, F. Rauter, J. Pombo, M. Pereira, "A Flexible Multibody Pantograph Model for the Analysis of the Catenary-Pantograph Contact", in K. Arczewski et al. (Eds.), *Multibody Dynamics: Computational Methods and Applications, Computational Methods in Applied Sciences*, Volume 23, Springer, pp.1-27, 2011 (DOI: 10.1007/978-90-481-9971-6_1)
10. N.M.M. Maia, M.M. Neves, Y.E. Lage, "Recent Advances on Force Identification in Structural Dynamics, Advances in Vibration Engineering and Structural Dynamics", in F. Beltran-Carbajal (Ed.), *Advances in Vibration Engineering and Structural Dynamics*, InTech, Chapter 6, pp.103-132, ISBN 978-953-51-0845-0, 2012 (DOI: 10.5772/51650)

9.4.5 Conference proceedings

1. J. Ambrósio, J. Pombo, F. Rauter, M. Pereira, "Multiple Pantograph Interaction with Catenaries in High-Speed Trains", Proceedings of the 8th World Congress on Railway Research, Seoul, Korea, May 18-22, 2008
2. F. Moleiro, C.M. Mota Soares, C.A. Mota Soares, J.N. Reddy, "Assessment of a Layerwise Mixed Least-Squares Model for Analysis of Multilayered Piezoelectric Composite Plates", in B.H.V. Topping, J.M. Adam, F.J. Pallarés, R. Bru, M.L. Romero, (Editors), "Proceedings of the Tenth International Conference on Computational Structures Technology", Valência, Spain, 14-17 September, 2010, Civil-Comp Press, Stirlingshire, UK, Paper 83, 2010 (doi:10.4203/ccp.93.83)
3. M. Carvalho, J. Ambrosio, J. Milho, Sensitivity Analysis of Railway Vehicle Interiors for Passive Safety in Inline Seating Scenarios, 5th Asian Conference on Multibody Dynamics 2010 (ACMD2010), Kyoto, Japan, 23-27 August, 2010 (ISBN: 978-1-61839-088-2, pp.479-487)
4. S.B. Gonçalves, M.T. Silva, J.M. Martins, M.C. Neves, "Advanced Computer Methods for Pathological and Non-Pathological Human Movement Analysis", EUROMECH Colloquium 511 on Biomechanics of Human Motion, Ponta Delgada, Azores, Portugal, March 9-12, 2011 (paper 75)
5. M.R.B. Dias, P.R. Fernandes, J.M. Guedes, S.J. Hollister, "Scaffold Design for Bone Tissue Engineering", in P.R. Fernandes et al. (ed.), Proceedings of II International Conference on Tissue Engineering, pp. 17-24, IST Press, ICTE2011, Lisboa, Portugal, 2-4 June, 2011
6. A.L. Araújo, C.M. Mota Soares, C.A. Mota Soares. Material identification in viscoelastic damped multifunctional structures, Plenary Lecture at The Sixth M.I.T. Conference on Computational Fluid and Solid Mechanics - Focus: Solids & Structures, Boston, U.S.A, 15-17 June, 2011
7. P.G. Coelho, C. Flanagan, S. Hollister, P.R. Fernandes and H. Rodrigues, Assessment of Elastic Properties of Scaffolds for Bone Tissue Engineering Obtained by Selective Laser Sintering, 10th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering. CMBBE2012, Hotel Berlin, Berlin, Germany, 11-14 April, paper CM232, 2012
8. N.S. Ribeiro, J. Folgado, H.C. Rodrigues, Shape Optimization of a Balloon Expandable Coronary Stent, in G. Holzapfel and R. Ogden (Eds.), ESMC 2012 - 8th European Solid Mechanics Conference, Graz, Austria, 9-13 July, 2012 (paper ID: 74528, ISBN: 978-3-85125-223-1)
9. H. Policarpo, M.M. Neves, N.M.M. Maia, "On using composition cork damping layer for surface damping treatment", International Conference on Noise & Vibration Engineering, pp.1-12, 2012
10. R.T.L. Ferreira, H. Rodrigues, J.M. Guedes, J.A. Hernandez, Hierarchical optimization of fiber reinforced composites, 4th International Congress on Computational Mechanics and Simulation (ICCMS 2012), IIT Hyderabad, December 10th, 2012

9.4.6 New materials, devices, products and processes

1. P. Melo, J.M. Martins, M.T. Silva, "Physical Prototype of a 4 Channel Asynchronous Functional Electrical Stimulator for Skeletal Muscle Activation", IDMEC, DEM, IST, 2012
2. C. Vasconcelos, J.M. Martins, M.T. Silva, "Physical Prototype of an Active Ankle Foot Orthosis", IDMEC, DEM, IST, 2012

9.4.7 Software, computer code and algorithms

1. M.T. Silva, "APOLLO", program for dynamic analysis of tri-dimensional multibody mechanical systems, IDMEC, DEM,
2. J.M. Guedes, "PREMAT", computer code to compute homogenized properties for composite/cellular materials, Versio 2012
3. J. Pombo, "AD-DAP-3D/Rail - Advanced Dynamic Analysis Program 3D/Rail", program to study the 3D dynamic behavior Superior Técnico, Lisbon, Portugal, 2009
4. C. Quental, J. Folgado, H. Rodrigues, P. Fernandes, "BONADAPT - code for bone adaptation", software to simulate loading using the Lisbon bone remodeling model (Fernandes et al., CMBBE, 2 (2), 1999), Version 2, IDMEC, IST, Lisbon
5. R. Portal, L. Sousa, J. Dias, Determination of the minimum distance between two Super Ellipsoids surfaces. Using Op (<http://www.mathworks.com/matlabcentral/fileexchange/40673-determination-of-the-minimum-distance-between-two-sup>)
6. A.L. Custódio, J.F.A. Madeira, A.I.F. Vaz and L.N. Vicente, "Direct MultiSearch (DMS)", a solver for derivative-free mu Version 0.2, 2011 (Web Page: <http://www.mat.uc.pt/dms>)
7. P. Coelho, P.R. Fernandes, J.M. Guedes, H. Rodrigues, "BONADAPT - MS: A Multi-scale code for bone adaptation", : adaptation to the mechanical loading taking into account two scales, the whole bone (apparent density) and the trabecular microstructures mechanically equivalent to the trabecular bone that can be used to produce tailored bone substitutes, ID
8. P. Antunes, J. Pombo, J. Ambrósio, M. Pereira, "PantoCat - Pantograph-Catenary Dynamic Interaction Analysis Program of the pantograph-catenary interaction using finite element and multibody approaches, Instituto Superior Técnico, Lisbon
9. J.M. Guedes, "POSTMAT-SOLID", computational of stresses at a microstructural level for composite/cellular materials 2012

10. C. Quental, J. Folgado, J. Ambrósio, "KDSM - Kinematic and Dynamic Shoulder Model", computer code for the kinematic human shoulder using multibody approaches, IDMEC, IST, 2012

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

1. Nuno M.M. Maia, "Introdução à Dinâmica Analítica", IST Press, ISBN: 978-972-8469-14-6, 2008 (146 pag.)
2. P.J. Bártolo, P.R. Fernandes, R.B. Ruben, J. Folgado, H. Almeida, N. Alves, A. Mendes (Eds.), "Proceeding of ICTE2009, International Conference on Tissue Engineering", IST-Press, Lisboa, ISBN: 978-972-8469-90-0, 2009
3. H. C. Rodrigues, J.M. Guedes, P. R. Fernandes, J. O. Folgado, M. M. Neves (Eds.) "Book of Abstract and CD-ROM Proceedings of WCSMO-8, Eighth World Congress on Structural and Multidisciplinary Optimization", APMTAC, Lisboa, ISBN: 978-989-20-1554-5, 2009
4. J. Ambrósio and M. Tavares da Silva (Eds.), Proceedings of the 7th EUROMECH Solid Mechanics Conference: Lectures and General Sessions, APMTAC, Lisboa, ISBN: 978-989-96264-2-3, 2009
5. Heitor Pina, "Métodos Numéricos", Escolar Editora, ISBN 9789725922842, 2010 (888 pag.)
6. H. Rodrigues, J. Herskovits, C. Mota Soares, J.M. Guedes, J. Folgado, A. Araújo, F. Moleiro, J.P. Kuzhichalil J. Aguiar Madeira, Z. Dimitrovová, "EngOpt2010: 2nd International Conference on Engineering Optimization - Book of Abstracts and CD-ROM Proceedings", APMTAC, ISBN: 978-989-96264-3-0, 2010
7. P.R. Fernandes, P.J. Bártolo, J. Folgado, H.C. Rodrigues, R.B. Ruben, H. Almeida, M.R. Dias (Eds.), "Proceeding of ICTE2011, II International Conference on Tissue Engineering", IST-Press, Lisboa, ISBN:978-989-8481-02-3, 2011
8. N.M.M. Maia, M.M. Neves, R.P.C. Sampaio, "Book of Abstracts and CD of Proceedings of the International Conference on Structural Engineering Dynamics (ICEDyn 2011), ICEDyn, ISBN 978-989-96276-1-1, 2011
9. A. Silva, C. Tavares Ribeiro, J. Dias e L. Sousa, "Desenho Técnico Moderno - Mecânica e Civil"; 12ª Edição, Editora Lidel, ISBN: 978-972-757-337-0, 2012 (704 pag)
10. J. Pombo (Editor), "Proceedings of the First International Conference on Railway Technology: Research, Development and Maintenance", Civil-Comp Press, Stirlingshire, UK, ISBN: 978-1-905088-53-9, 2012 (doi:10.4203/ccp.98)

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

1. C.A. Mota Soares, J. Holnicki-Szulc, A. Suleman, C.M. Mota Soares (Guest Editors), Special Issue: Smart Structures, Computers & Structures, Elsevier, UK, Vol. 86 (3-5), February 2008 (DOI: 10.1016/j.compstruc.2007.01.029)
2. C.A. Mota Soares, C.M. Mota Soares (Guest Editors), Special Issue: Composites, Computers & Structures, UK, Vol. 86 (9), May 2008 (DOI: 10.1016/j.compstruc.2007.05.018)
3. J. Wismans, J. Ambrósio (Guest Editors), Special Issue: Advanced Protection Systems (APROSYS) Part 1 and Part 2, International Journal of Crashworthiness, 13(6), 2008 and 14(3), 2009 (DOI: 10.1080/13588260802525421 and DOI: 10.1080/13588260903073131)
4. C.A. Mota Soares, W. Ostachowicz and J. Holnicki-Szulc (Guest Editors), Special Issue: III ECCOMAS Thematic Conference on Smart Structures and Materials, Mechanics of Advanced Materials and Structures, Taylor and Francis, UK, Vol. 16 (3), April 2009 (DOI: 10.1080/15376490902746723)
5. J. Ambrosio and W. Schiehlen (Guest Editors), Special Issue: Selected Papers from the 22nd International Congress of Theoretical and Applied Mechanics, Adelaide, 24-29 August 2008, Vehicle Systems Dynamics, 48(1), 2010 (DOI:10.1080/00423110903533780)
6. J. Blachut, C.M. Mota Soares (Guest Editors), Special Issue: Modeling, Simulation and Testing of Composite and Adaptive Structures, Mechanics of Advanced Materials and Structures, Taylor and Francis, UK, Vol. 18 (2), March 2011 (DOI:10.1080/15376494.2011.547428)
7. J. Herskovits, H.C. Rodrigues, C.A. Mota Soares, C. Sagastizábal, A.R. Secchi (Guest Editors), Special Issue dedicated to EngOpt - an International Conference on Engineering Optimization, Rio de Janeiro Brazil, June 1-5, 2008, Optimization and Engineering, Vol.12 (1-3), Springer, March 2011 (DOI: 10.1007/s11081-010-9124-0)
8. F.C.T. van der Helm, M.T. Silva, P. Flores, A. Kecskeméthy (Guest Editors), Thematic Issue on Biomechanics of Human Motion, Multibody Systems Dynamics, 28(1), pp1-2, 2012 (DOI: 10.1007/s11044-012-9315-x)
9. Paulo Fernandes, João Folgado and Miguel Silva (Guest Editors), Journal of Biomechanics, Vol. 45, Supplement 1, July 2012, ESB2012 - Proceedings of the 18th Congress of the European Society of Biomechanics, Lisbon, Portugal, 1-4 July, 2012 (DOI: 10.1016/S0021-9290(12)70001-5)
10. N.M.M. Maia, M.M. Neves (Guest Editors), Special Issue: International Conference on Structural Engineering Dynamics - ICEDyn 2011, Shock and Vibration, IOS Press, Vol. 19, N. 5, 2012 (DOI: 10.3233/SAV-2012-0725)

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

1. J. Ambrósio, "Optimization of Flexible Multibody Systems", in J. Ambrósio and P. Eberhard (Eds.), *Advanced Design of Mechanical Systems: From Analysis to Optimization*, CISM International Centre for Mechanical Sciences, Volume 511, Springer-Verlag, Wien, Austria, ISBN: 978-3-211-99460-3, pp.375-426, 2009
2. R. Sampaio and N.M.M. Maia, "A Simple Correlation Factor as an Effective Tool for Detecting Damage", in J. Awrejcewicz (Ed.), *Modeling, Simulation and Control of Nonlinear Engineering Dynamical Systems - State-of-the-art, Perspectives and Applications*, Springer-Verlag, ISBN 978-1-4020-8777-6, pp 233-242, 2009 (DOI: 10.1007/978-1-4020-8778-3_21)
3. J. Pombo, J. Ambrósio, "Development of Realistic Three-Dimensional Track Models for Railway Vehicle Dynamic Analyses", in B.H.V. Topping and Y. Tsompanakis, (Editor), *Civil and Structural Engineering Computational Technology*, Saxe-Coburg Publications, Stirlingshire, UK, Chapter 3, pp 65-98, 2011 (doi:10.4203/cssets.28.3)
4. M.T. Silva, A.F. Pereira, J.M. Martins, "An Efficient Muscle Fatigue Model for Forward and Inverse Dynamic Analysis of Human Movements", in J. McPhee and J. Kovecses (Eds.), *IUTAM Symposium on Human Body Dynamics*, Procedia IUTAM, Volume 2, pp.262-274, Elsevier, 2011 (DOI: 10.1016/j.piutam.2011.04.024)
5. J. Ambrósio, C. Quental, B. Pilarczyk, J. Folgado, J. Monteiro, "Multibody biomechanical models of the upper limb", in J. McPhee and J. Kovecses (Eds.), *IUTAM Symposium on Human Body Dynamics*, Procedia IUTAM, Volume 2, pp.4-17, Elsevier, 2011 (DOI: 10.1016/j.piutam.2011.04.002)
6. N.M.M. Maia, A.P.V. Urgueira, R.A.B. Almeida, "Whys and Wherefores of Transmissibility", in F. Beltran-Carbajal (Ed.), *Vibration Analysis and Control - New Trends and Developments*, InTech, Chapter 10, pp.197-216, ISBN 978-953-307-433-7, 2011 (DOI: 10.5772/24869)
7. J. Ambrósio, A Kinematics Based Methodology for the Design of Gangways and Coupler Housings of Railway Vehicles, in A. Kecskeméthy, V. Potkonjak, A. Müller (Eds.), *Interdisciplinary Applications of Kinematics*, ISBN 978-94-007-2977-3, pp.37-54, 2011 (DOI: 10.1007/978-94-007-2978-0_3)
8. J.V. Araújo dos Santos, H. Lopes, "Application of Speckle Interferometry to Damage Identification", in B.H.V. Topping, (Editor), *Computational Methods for Engineering Science*, Saxe-Coburg Publications, Stirlingshire, UK, Chapter 12, pp 299-330, 2012 (doi:10.4203/cssets.30.12)
9. J. Pombo, P. Antunes, J. Ambrósio, "A Study on Multiple Pantograph Operations for High-Speed Catenary Contact", in B.H.V. Topping, (Editor), *Proceedings of the Eleventh International Conference on Computational Structures Technology*, Civil-Comp Press, Stirlingshire, UK, Paper 139, 2012 (doi:10.4203/ccp.99.139)
10. A.L. Custódio, M. Emmerich, J.F.A. Madeira, "Recent Developments in Derivative-Free Multiobjective Optimisation", in *Computational Technology Reviews*, Saxe-Coburg Publications, Vol. 5, pp. 1-30, ISBN 978-1-874672-59-3, 2012 (doi:10.4203/ctr.5.1)

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

1. TV, SIC / SIC Notícias, Falar Global, Medicina tecnológica, Dachor Project, 2010, <http://sic.sapo.pt/programasInformacao/scripts/videoplayer.aspx?ch=falarglobal&videoid=%7B97F31E48-48AF-4DFB-B817-4DC4D818A26E%7D>
2. TV, SIC, ACCIDENT RECONSTRUCTION, http://www.dem.ist.utl.pt/~m_gc/download/SIC2.mpg
3. Radio, TSF, Programa Mundo Novo (New World Program), Biomecânica do Movimento (Biomechanics of Movement), 2012, Link: http://www.tsf.pt/Programas/programa.aspx?content_id=1221266&audio_id=2631430
4. Radio, TSF, Programa Mundo Novo (New World Program), Dachor Project, 2011, Link: http://www.tsf.pt/Programas/programa.aspx?content_id=1221266&audio_id=2021876

9.4.16 Other research outputs

1. Prof. Carlos Mota Soares is: Honorary Fellow of IACM; Fellow ECCOMAS; 2009 Distinguished Ibero - American Person in Mechanical Engineering; President of Portuguese Association of Theoretical, Applied and Computational Mechanics; National Delegate to NMP program of UE
2. Prof. M. Seabra Pereira is National Delegate to Transport Program UE and Vice-Chairman of the Technological

Platform ERRAC - The European Rail Research Advisory Council

3. Profs. Jorge Ambrosio, Paulo Fernandes and Helder Rodrigues: members of the executive boards of EUROMECH - European Mechanics Society, ESB - European Society of Biomechanics and ISSMO - International Society for Structural and Multidisciplinary Optimization, respectively
4. Prof. Helder Rodrigues is member of the Lisbon Academy of Sciences
5. Editors of International Scientific Journals: Prof. Jorge Ambrósio is the Editor-in-Chief of "Multibody System Dynamics", Springer and Prof. João Pombo is the Editor of "The International Journal of Railway Technology", Saxe-Coburg Publications
6. Researchers of the Mechanical Design Group are members of the Editorial Boards of about 20 international scientific journals, such as: Composites Part B (Elsevier), Multibody Systems Dynamics (Springer), Structural and Multidisciplinary Optimization (Springer), Computers and Structures (Elsevier), Vehicle Systems Dynamics (Taylor and Francis), International Journal of Crashworthiness (Springer), Computer Methods in Biomechanics and Biomedical Engineering (Taylor and Francis), Mechanics of Advanced Materials and Structures (Taylor and Francis), Shock and Vibration (IOS Press), International Journal for Simulation and Multidisciplinary Design Optimization (EDP Sciences), Periodica Polytechnica, International Journal for Computation Vision and Biomechanics (Serials Publications), Journal of Theoretical and Applied Mechanics
7. Prize "Ser Capaz - Investigação e Tecnologia 2011", Associação Salvador, awarded to Miguel Silva, Jorge Martins, Paulo Melo, Carlos Vasconcelos, project "DACHOR - Integrated Design and Control of Hybrid Active Orthoses"
8. Prof. Cristovão Mota Soares awarded the prize "Excellence in Research", ICCS-International Conference on Composites Structures, 29 June 2011
9. "Young Researcher Best Paper Prize", awarded to Prof. Filipa Moleiro for the work F. Moleiro, C.M. Mota Soares, C.A. Mota Soares, J.N. Reddy, "A layerwise mixed least-squares finite element model for static analysis of multilayered composite plates", in B.H.V. Topping, M. Papadrakakis, (Editors), Proceedings of the Ninth International Conference on Computational Structures Technology, Athenas, Greece, 2-5 September, 2008, Civil-Comp Press, Stirlingshire, UK, Paper 5, 2008 (DOI: 10.4203/ccp.88.5)
10. "Young Researcher Best Paper Prize", awarded to Prof. Pedro Coelho for the work P.G. Coelho, J.B. Cardoso, P.R. Fernandes, H.C. Rodrigues, "Parallel Computing Techniques Applied to the Simultaneous Design of Structure and Material", in B.H.V. Topping, P. Iványi, (Editors), Proceedings of the First International Conference on Parallel, Distributed and Grid Computing for Engineering, Pécs, Hungary, 6-8 April, 2009, Civil-Comp Press, Stirlingshire, UK, Paper 35, 2009 (doi:10.4203/ccp.90.35)

9.4.17 Organisation of scientific dissemination activities

1. WCSMO-8 - 8th World Congress of Structural and Multidisciplinary Optimization, LNEC, Lisbon, Portugal, June 1-5, 2009 (420 participants)
2. NATO-RTO Applied Vehicle Technology Panel (AVT) Symposium (RTO-MP-AVT-168 - Morphing Vehicles), Évora, Portugal, 20-24 April 2009 (300 participants)
3. ICEDyn - International Conference on Structural Engineering Dynamics, Ericeira, Portugal, June 22-24, 2009 (180 participants) and Tavira, Portugal, June 20-22, 2011 (140 participants)
4. ICTE - International Conference on Tissue Engineering: an ECCOMAS Thematic Conference, Leiria, Portugal, 9-11 Julho, 2009 (90 participants) and Lisboa, Portugal, 2-4 June, 2011 (80 participants)
5. ESMC2009 - 7th EUROMECH Solid Mechanics Conference, IST, Lisbon, Portugal, September, 7-11, 2009 (600 participants)
6. ENGOPT2010 - 2nd International Conference on Engineering Optimization, Lisbon, Portugal, 6-9 September 2010 (370 participants)
7. EUROMECH Colloquium 511 on Biomechanics of Human Motion. New Frontiers of Multibody, Techniques for Clinical Applications, Ponta Delgada, Azores, Portugal, March 9-12, 2011 (95 participants)
8. Scientific Workshop on Microscale Modeling and Mechanobiology, Ericeira, Portugal, 2011 (60 participants)
9. Railways 2012 - The 1st International Conference on Railway Technology: Research, Development and Maintenance, Las Palmas de Gran Canaria, Spain, April 18-20, 2012 (210 participants)
10. ESB2012 - 18th Congress of the European Society of Biomechanics, Lisbon, Portugal, 1-4 July, 2012 (800 participants)

9.4.18 Research contracts with national or international entities

1. Force Identification and Transmissibility in Multiple-Degree-Of-Freedom Systems, financing received by IDMEC/IST 50K€ (financed by FCT, PTDC/EME-PME/71488/2006), 2007-2010
2. Design of cellular elastomeric materials for passive vibration control, financing received by IDMEC/IST 40K€ (financed by FCT, PTDC/EME/PME/67658/2006), 2007-2010
3. ACCIDENT RECONSTRUCTION, financing received by IDMEC/IST 150K€ (financed by public and private entities),

2008-2012

4. BONENG: Development of Scaffolds with Controlled Microstructure for Bone Tissue Engineering, financing received by IDMEC/IST 73K€ (financed by FCT, PTDC/EME-PME/104498/2008), 2010-2013
5. SMARTRACK: System dynamics assessment of railway tracks: a vehicle-infrastructure integrated approach, financing received by IDMEC/IST 80K€ (financed by FCT, PTDC/EME-PME/101419/2008), 2010-2013
6. WEARWHEEL - Wear of Railway Vehicles Steel Wheels, financing received by IDMEC/IST 59K€ (financed by FCT, PTDC/EME-PME/115491/2009), 2011-2014
7. Ministério da Administração Interna (M.A.I.) - A Física dos Acidentes, financing received by IDMEC/IST 38K€ (financed by M.A.I.), 2012
8. Ministério da Administração Interna (M.A.I.) - A Segurança dos Utentes Vulneráveis, financing received by IDMEC/IST 49K€ (financed by M.A.I.), 2012
9. POMSTCE: Optimal design and material synthesis of ambient vibrational energy harvester for micro/nano devices, financing received by IDMEC/IST 61K€ (financed by FCT, PTDC/EME-PME/120630/2010), 2012-2013
10. COMPOPT: Optimal design of laminated thermo-piezo-viscoelastic composites, financing received by IDMEC/IST 79K€ (financed by FCT, PTDC/EME-PME/120830/2010), 2012-2013

9.4.19 Projects funded in national and international competitive calls

1. CASSEM: Composite and Adaptive Structures: Simulation, Experimentation and Modelling, financing received by IDMEC/IST 120K€ (financed by EC, FP6), 2005-2008
2. FRIENDCOPTER: Integration of Technologies in support of a passenger and environmentally friendly helicopter, financing received by IDMEC/IST 211K€ (financed by EC, 6th Framework Programme), 2004-2009
3. APROSYS: Advanced Protection Systems, financing received by IDMEC/IST 196K€ (financed by EC, FP6), 2004-2009
4. PROHELM: Accident Prevention Options with Motorcycle Helmets, financing received by IDMEC/IST 14K€ (financed by EC, COST 357), 2005-2009
5. SAFEINTERIORS: Train Interior Passive Safety for Europe, financing received by IDMEC/IST 317K€ (financed by EC, 6th Framework Programme), 2006-2010
6. Aeroelastic Scaling of a Joined Wing Aircraft Concept, financing received by IDMEC/IST 100K€ (financed by U.S. Air Force, EOARD AWARD No. FA8655-08-1-3071), 2008-2011
7. SKILLRAIL: Training and Education for a more Competitive and Innovative Railway Sector, financing received by IDMEC/IST 110K€ (financed by EC, FP7), 2009-2011
8. PANTOTRAIN: PANTOgraph and catenary interaction: Total Regulatory Acceptance for the Interoperable Network, financing received by IDMEC/IST 256K€ (financed by EC, FP7), 2009-2012
9. DACHOR: Multibody Dynamics and Control of Hybrid Active Orthoses, financing received by IDMEC/IST 165K€ (financed by FCT, MIT Portugal Program), 2009-2012
10. NOVEMOR: NOVel Air VEHICLE Configurations: From Fluttering Wings to MORphing Flight, financing received by IDMEC/IST 279K€ (financed by EC, FP7), 2011-2014

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The Mechanical Design group (with 43 PhD integrated members)

is organized in three R&D areas according to their main research topics and whose activities are coordinated by a senior scientist:

Helder C. Rodrigues (Full Professor) will head the group and simultaneously coordinate the research activities in Modelling and Optimization of Structures and Materials.

Jorge C. Ambrósio (Full Professor) will coordinate the research activities in Simulation and Design of Mechanical Systems.

Luis Guerra Rosa (Associate Professor w/Habilitation) will coordinate the research activities in Structural Materials and Advanced Characterization.

João O. Folgado (Assistant Professor) will assist the head of the group in the interface with IDMEC/LAETA.

A senior scientist will direct the different laboratories and coordinate the available resources:

Miguel T. Silva (Assistant Professor) will be the responsible for the Laboratory of Biomechanics: Human movement.

Paulo A. Fernandes (Associate Professor w/Habilitation) will be the responsible for the Laboratory of Biomechanics: Tissue Biomechanics.

Pedro Amaral (Assistant Professor) will be the responsible for the Experimental Mechanics Laboratory

António Relógio Ribeiro (Assistant Professor) will be the responsible for the Laboratory of Vibrations.

Luis Reis (Associate Professor) will be the responsible for the Laboratory of Composite Materials.

9.5.2 Objectives of the Research Group

The research group is engaged on the development of experimental testing, computational analysis and development of analytical models to support the mechanical design process and apply them in the design of a wide range of products, namely mechanical components and structures in transportation (highway, railroad, maritime, space) and to medical devices. The objective is to integrate experimental, analytical and computational analysis models with optimal and multidisciplinary design methodologies to support the design of components and structures and the selection (or design) of the materials used in their manufacture. These methodologies, integrating the design of the components and structures with the selection or design of the materials, will allow unconventional and innovative design developments with strong economical and social impacts.

The research will be carried in the group R&D areas and answering LAETA's thematic lines objectives:

Transport Technology: Development of advanced structural dynamics analysis models, advanced materials design and optimal design methodologies necessary to tackle LAETA tasks in: railway dynamics (advanced wheel-rail contact models, pantograph-catenary interaction and infrastructure modelling), vehicles dynamics (suspension systems, structural flexibility, occupant comfort) and increase passive safety of occupants (structural crashworthiness and passenger injury)

Aeronautics and Space: Development of analytical and experimental models for characterization of composites failure, namely damage mechanisms occurring in advanced composites (e.g. matrix cracks, fibre fracture) and perform structural integrity analyses. Extend these studies through nano, micro and meso mechanics materials analysis models. Integrate these models with optimal design methodologies to project advanced materials (e.g. composites, laminates and cellular materials) for aeronautics applications with improved properties (e.g. damage tolerance, strength, stiffness/ weight ratio).

Biomechanics: Development of computational multiscale biomechanical models to characterize the behaviour of biological materials, (muscles and bones) and apply them in: (i) Improvement of scaffolds for bone tissue engineering. (ii) Study the biomechanical control of the bone adaptation process and (iii) design of bone prostheses. Development of models based in multibody dynamics tools and experimentally gathered movement data, to analyse the gait patterns. Apply these models in: (i) Analysis of pathologic and non-pathologic gait. (ii) Design of orthotic medical devices to support locomotion (iii) support clinical decisions in rehabilitation and orthopaedics.

Advanced Materials: Mechanical characterization of cellular materials (cork, bone, foams), ceramic materials and composite materials (fibre reinforced polymers and metals); Assessment techniques, including SEM (scanning electron microscopy) and TEM (transmission electron microscopy); Development of multiscale methods for the analysis of laminated, sandwich, piezoelectric and functionally graded materials; Modelling and simulation at molecular level of carbon-based nano materials (nanotubes, graphene, graphyne) for reinforcement of lighter materials; Development of innovative methodologies for the detection, localization and characterization of damage in engineering materials, including fracture failure and crack propagation analysis; Constitutive modelling and fatigue assessment of materials under multiaxial and cyclic loading. Continuous revision and improvement of existing material standards and design codes.

Engineering Design: Development of multidisciplinary design methodologies in mechanical design. Development of multi-criteria optimization tools. Modeling the materials selection process with optimization techniques. Modelling of the interaction between product architecture, materials and process selection in engineering design.

(RG-50022-1624) Renewable and Sustainable Energy Systems

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1624

9.1.2 Name of the Research Group in portuguese

Sistemas de Energia Renováveis e Sustentáveis

9.1.3 Name of the Research Group in English

Renewable and Sustainable Energy Systems

9.1.4 Keyword(s)

Heat Transfer

Computational Fluid Dynamics

Clean Combustion

Renewable Energy

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica (IDMEC)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator	Nuclear CV
Antonio Franco de Oliveira Falcao	No	No
Carla Alexandra Monteiro da Silva	No	No
Carlos Frederico Neves Bettencourt da Silva	No	No
Cláudia Sofia Séneca da Luz Casaca	No	No
Goncalo Nuno Antunes Goncalves	No	No
Isabel Maria Pereira Bastos Malico	No	No
Joao Manuel Melo de Sousa	No	No
José Carlos Fernandes Pereira	No	Yes
José Manuel da Silva Chaves Ribeiro Pereira	No	No
João Carlos de Campos Henriques	No	No
João Luis Toste de Azevedo	No	No
Luís Manuel de Carvalho Gato	No	No
Maria da Graca Martins da Silva Carvalho	No	No
Mário Manuel Gonçalves Costa	Yes	Yes
Patrícia de Carvalho Baptista	No	No
Pedro Jorge Martins Coelho	No	Yes
Pedro Manuel da Silva Cardoso Isidro Valente	No	No
Rui Pedro da Costa Neto	No	No
Sandra Maria de Brito Monteiro de Melo	No	No
Tiago Alexandre Abranches Teixeira Lopes Farias	No	No
Viriato Sérgio Almeida Semião	No	No

9.2.2 List of current PhD students

NAME

Ulisses Mendes Fernandes

Sandrina Batista Pereira

Raquel Inês Segurado Correia Lopes da Silva

Catarina Maria da Cunha de Eça Calhau Rolim

Miriam Estefânia Rodrigues Fernandes Rabaçal

João Filipe Pinto Ribau

Carlos Duarte da Silva Completo

Manuel João Colaço Barbas

9.2.3 List of other researchers of the Research Group

NAME

Tomas Claudio Rei Fernandes

Alexandre de Tilly

Amandio Jorge Barroso Rebola

Ana Leal Serpa de Vasconcelos

Rui Pedro Fragoso Pimenta

Nuno Ricardo da Piedade Antunes Serra

Ana Filipa da Silva Ferreira

Gongliang Wang

Ana Marta de Vitorino Faria

Gonçalo Nuno de Oliveira Duarte

Sara Sofia Rodrigues Marques

Tiago Filipe Pereira Novais

Alexandre Nuno Rocha Pinto Lucas

Maxime Pierre Laurent Roger

Tiago de Brito Carvalho

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

The members of the Renewable and Sustainable Energy Systems group have been engaged in both fundamental and applied research in several energy related topics for more than 20 years. The research covers a broad range of fundamental topics directly related to energy such as heat transfer, turbulence physics and modeling, computational fluid dynamics, and experimental fluid mechanics, and also specific energy application topics such as energy efficiency, renewable energy, hydrogen and fuel cells, clean combustion, energy and environment in transports and turbomachinery. Presently the group is composed of 21 senior researchers plus around 30 PhD and Msc students, and this number has been stable and is expected to remain so in the future.

The fundamental research carried out in the group during the period 2008/2012 includes: investigation of the turbulent/radiation interaction for non-reacting and reacting flows, developments of hybrid methods for the solution of the radiative transfer equation; investigation of the turbulent entrainment in free shear flows, study of viscoelastic turbulence dynamics, development of mathematical and computational tools to study uncertainty in reactive flows, study of forest fire propagation, characterization of isothermal microflows of biological and non-biological fluids and flameless and oxy-fuel combustion.

The applied research carried out in the group during the period 2008/2012 includes: investigation of co-combustion of coal with biomass, study of the formation of fine particulate matter in biomass combustion; development of design tools for air turbines for wave energy conversion and for small cross-flow hydraulic turbines; development of ocean wave energy utilization, development and promotion of tools and practices for energy management, urban planning and new and renewable energy technologies, development of tools to assess the potential for renewable energy technologies in developing countries and remote regions; development region's environmental indicators for the road transport sector, and examination of the algal industrial biorefineries viability and sustainability.

The group has various computational and experimental laboratories, occupying a total area of around 300 m², which is largely well equipped with commercial equipment and instrumentation but also with a significant amount of in-house computational tools/codes, and designed test sections, including a large-scale furnace which is able to fire either gaseous, liquid and solid fuels, including biofuels.

During the period 2008/2012 the group published around 150 articles in peer reviewed international journals and various researchers of the group received national and international awards for their scientific achievements. Most of the researchers of the group have strong links with the international research community in terms of collaborative

research work. The research activities during the period 2008/2012 have been funded by i) the national science foundation (FCT), ii) the European Union, iii) government and public institutions, and iv) private companies (national and international).

9.3.2 Main achievements

In terms of scientific indicators the overall research achievements of the Renewable and Sustainable Energy Systems group during the period 2008/2012 were the following: publications in international journals with peer review (143), publications presented in international conferences (225), publications in national conferences (27), PhD theses completed (36) and MSc theses completed (146).

In terms of research and development work the main achievements of the Renewable and Sustainable Energy Systems group during the period 2008/2012 were the following:

In the area of heat transfer: i) development of hybrid finite volume/finite element method and evaluation of the accuracy (using bilinear and spherical triangular basis functions) of radiative transfer computations; ii) development of a theoretical analysis of the influence of turbulence on radiative emission in turbulent diffusion flames; iii) development of a computer code based on OpenFoam for the large eddy simulation of turbulent heated jets.

In the area of turbulence physics and modeling: i) characterization of the turbulent entrainment mechanism in free shear flows (including the subgrid-scale modeling), ii) development/validation of new modeling strategies for large-eddy simulation (including turbulent-radiation interaction in simulations of turbulent heated jets).

In the area of new computational paradigms and CFD: i) robust and accurate modelling of reactive flows in inert porous media, ii) development of new refinement criteria strategies with the purpose of application to multiscale problems.

In the area of modelling and experimental fluid mechanics: i) modelling and measurement of dispersion and deposition of dry-powder aerosols, including the development of a particle-based computational methodology; ii) production and optimization of the aerodynamic characteristics of particles for inhalation; iii) demonstration of low-Reynolds-number flow concepts for passive stall control and pulsed propulsion in micro-aerial-vehicles.

In the area of microfluidics: i) establishment of a laboratory; ii) advances on several steady and unsteady microflows for both Newtonian and non-newtonian fluids, including blood; iii) computational work with Lattice-Boltzmann body-force models for rotating flows developed.

In the area of renewable energy: geometry optimization and model testing of a new patented geometry for spar-buoy OWC wave energy converter; non-linear modelling of moorings for arrays of floating wave energy converters.

In the area of fuel cells/hydrogen energy: i) preparation of a Redox 10 W reversible battery; ii) establishment of a procedure to prepare the electrolyte.

In the area of clean combustion: i) successful application of the eddy dissipation concept and the transport pdf method to the simulation of combustors operating in the flameless regime; ii) advances in the understanding of the flameless and oxy-fuel combustion modes; iii) quantification of the particulate matter inside a domestic biomass-fired boiler and evaluation of the fundamentals of particulate matter formation.

In the area of energy and environment in transports: i) ability to simulate the energy consumption of vehicles equipped with battery or with a ultracapacitor or with a combination of both; ii) ability to optimize a powertrain configuration combined with the energy management strategy for a specific probable driving profile; iii) development of methodologies to evaluate driver behavior based on collected speed profiles; iv) development of a laboratory to monitor hybrid and electric vehicles; v) development of and pedestrian mobility laboratory.

In the area of turbomachinery: i) a 15 kW impulse-type self-rectifying air turbine with controlled guide vanes was built and tested on a floating OWC wave energy prototype in Galway Bay, Ireland; ii) model of a novel patented bi-radial air turbine.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

1. Mendes, M. A. A., Pereira, J. M. C., Pereira, J. C. F., A numerical study of the stability of one-dimensional laminar premixed flames in inert porous media, *COMBUSTION AND FLAME*, 153, 525-539, 2008, DOI: 10.1016/j.combustflame.2008.03.010 (times cited: 20, impact factor: 3.599)
2. Falcão, Antonio F. de O., Phase control through load control of oscillating-body wave energy converters with hydraulic PTO system, *OCEAN ENGINEERING*, 35, 358-366, 2008, DOI: 10.1016/j.oceaneng.2007.10.005 (times cited: 28; impact factor: 1.161)
3. da Silva, Carlos B. and Pereira, Jose C. F., Invariants of the velocity-gradient, rate-of-strain, and rate-of-rotation tensors across the turbulent/nonturbulent interface in jets, *Physics of Fluids*, 20, 055101, 2008, DOI: 10.1063/1.2912513 (times cited: 26, impact factor: 1.942)
4. Tavares, G., Zsigraiova, Z., Semiao, V., Carvalho, M. G., Optimisation of MSW collection routes for minimum fuel consumption using 3D GIS modelling, *WASTE MANAGEMENT*, 29, 1176-1185, 2009, DOI: 10.1016/j.wasman.2008.07.013 (times cited: 27, impact factor: 2.485)
5. Ribeirete, A., Costa, M., Impact of the air staging on the performance of a pulverized coal fired furnace, *PROCEEDINGS OF THE COMBUSTION INSTITUTE*, 32, 2667-2673, 2009, DOI: 10.1016/j.proci.2008.06.061 (times cited: 21; impact factor: 2.374)
6. Silva, Carla; Ross, Marc; Farias, Tiago, Evaluation of energy consumption, emissions and cost of plug-in hybrid

vehicles, *Energy Conversion and Management*, 50, 1635-1643, 2009, DOI: 10.1016/j.enconman.2009.03.036 (times cited: 39, impact factor: 2.775)

7. Roger, Maxime; Coelho, Pedro J.; da Silva, Carlos B., The influence of the non-resolved scales of thermal radiation in large eddy simulation of turbulent flows: A fundamental study, *International Journal of Heat and Mass Transfer*, 53, 2897-2907, 2010, DOI: 10.1016/j.ijheatmasstransfer.2010.02.002 (times cited: 9, impact factor: 2.315)

8. Verissimo, A. S., Rocha, A. M. A., Costa, M., Operational, Combustion, and Emission Characteristics of a Small-Scale Combustor, *ENERGY & FUELS*, 25, 2469-2480, 2011, DOI: 10.1021/ef200258t (times cited: 12, impact factor: 2.853)

9. da Silva, Carlos B., dos Reis, Ricardo J. N.; Pereira, Jose C. F., The intense vorticity structures near the turbulent/non-turbulent interface in a jet, *Journal of Fluid Mechanics*, 685, 165-190, 2011, DOI: 10.1017/jfm.2011.296 (times cited: 6, impact factor: 2.183)

10. Gomes, R.P.F., Henriques, J.C.C., Gato, L.M.C. Falcão, A.F.O., Hydrodynamic optimization of an axisymmetric floating oscillating water column for wave energy conversion, *Renewable Energy*, 44, 328-339, 2012, DOI:10.1016/j.renene.2012.01.105 (times cited: 6, impact factor: 2.989)

9.4.2 Completed PhD theses

1. Cláudia S. S. L. Casaca, *Utilização de Biomassa como Combustível Secundário em Processos de Co-Combustão e Reburning*, PhD, IST, 2008.

2. Gonçalves, G. *Energy and Environmental Monitoring of Alternative Fuel Vehicles*. IST, 2009.

3. Miguel Abreu Almeida Mendes, *Modeling and simulation of hydrocarbon oxidation processes within porous inert media*, PhD, IST, 2010.

4. Gilberto António Monteiro Tavares, *Integration of waste-to-energy incineration in the municipal solid waste management system of Santiago Island: planning, process control and complementary activities*, IST, PhD, 2010.

5. Helder M. F. Santos, *Experimental and Numerical Investigation of Three Way Catalytic Systems for Automotive Vehicles*, PhD, IST, 2010.

6. Ana Serpa Leal de Vasconcelos, *Urban neighborhood accessibility and ensuing internal and external environmental costs*, PhD, IST, 2011.

7. Patrícia Baptista, *Evaluation of the impact of new vehicle and fuel Technologies in the road transport sector*, PhD, IST, 2011.

8. Miguel Filipe Pinho Lopes, *Experimental Development of Offshore Wave Energy Converters*, IST, PhD, 2011

9. Pierpaolo Ricci, *Modelling, Optimization and Control of Wave Energy Point-absorbers*, IST, PhD, 2012.

10. João Bravo, *Numerical modeling and simulation of energy management strategies for electric and hybrid vehicles*, PhD, IST, 2012.

9.4.3 Patents and Prototypes or other research outputs

1. A.F. de O. Falcão, J.J.M.B. Cândido and L.M.C. Gato, *Floating OWC device for wave energy conversion*, INPI, Lisbon, National patent nº105171, 2010.

2. A.F. de O. Falcão and L.M.C. Gato, *Turbine with radial inlet and outlet flow rotor for use in bi-directional flows*, WIPO, International patent nº WO2011102746A2, 2011.

3. P.A.P. Justino, A.F. de O. Falcão, and L.M.C. Gato, *Tubular hollow structure for floating oscillating water column wave energy conversion devices*, INPI, Lisbon, National patent nº 106415, 2012.

4. A.F.O. Falcão, L.M.C. Gato, *Turbina com rotor de entrada e saída radiais para aplicações em escoamentos bidireccionais*. Patente de Invenção Portuguesa No. 104972, 2012.

5. A.F.O. Falcão, L.M.C. Gato, J.J. Cândido, *Dispositivo flutuante de coluna de água oscilante para conversão da energia das ondas*. Patente de Invenção Portuguesa No. 105171, 2012.

9.4.4 Books and book chapters of international circulation

1. Eames, J.C.R. Hunt, M. Braza, C.B. da Silva, J. Westerweel (2011), "Interfaces in Turbulence and Implications for Advanced Modeling Methods", *ERCOFTAC Bulletin* 88, pp:17-19.

2. A.F.O. Falcão, L.M.C. Gato, *Air turbines*. In: Sayigh A, editor, *Comprehensive Renewable Energy*, vol. 8, Ocean Energy. Oxford: Elsevier; 2012, pp. 111-149.

3. A.F.O. Falcão. "Historical Aspects of Wave Energy Conversion". In: A. Sayigh (editor), *Comprehensive Renewable Energy*, vol. 8, Ocean Energy, chapter 2, pp. 7-9, Elsevier, 2012.

4. Camus, C., J. Esteves, and T.L. Farias, 2011, Chapter 8 - Integration of Electric Vehicles in the Electric Utility Systems, in *Electric Vehicles - The Benefits and Barriers*. Editor S. Soyulu, In Tech: Rijeka, Croatia. pp. 135-158.

9.4.5 Conference proceedings

1. Z. Zsigraiova, G. Tavares, V. Semiao, M. G. Carvalho, Monitoring and fault detection in MSW incineration process using multivariate statistical methods, 5th Dubrovnik Conf. Sustainable Development of Energy, Water and Environment Systems, Dubrovnik, Croatia, 2009.
2. Patricia Baptista, Carla Silva and Tiago Farias, Impact of the introduction of new vehicle technologies in the Portuguese road transportation sector, 1st Transatlantic NECTAR Conference 2009, Arlington, Virginia USA, 18-20 June, 2009.
3. da Silva, C.B. (2010) "The turbulent/nonturbulent interface in a planar jet: physics and subgrid-scale modeling", Euromech Colloquium 517 on Interfaces and Inhomogeneous Turbulence, London.
4. P.J. Coelho, "A General Closure Model for the Time-Averaged Radiative Transfer Equation in Turbulent Flows", 14th Int. Heat Transfer Conference, Washington, DC, 2010.
5. Taveira, R. R., da Silva, C. B. and Pereira, J.C.F. (2011) "The dynamics of turbulent scalar mixing near the edge of the shear layer", 13th European Turbulence Conference (ETC), Warsaw.
6. dos Reis, R.N., da Silva, C.B. and Pereira, J.C.F. (2011) "Vorticity Structures near the Turbulent/Nonturbulent Interface in a Planar Turbulent Jet", 7th International Symposium on Turbulence and shear flow phenomena (TSFP), Ottawa.
7. J.C.C. Henriques, M.F.P. Lopes, R.P.F. Gomes, L.M.C. Gato, A.F.O. Falcão, "Performance evaluation of a two-body heaving WEC with latching control using a new numerical method", 9th European Wave and Tidal Energy Conference, Southampton, UK, September 2011.
8. dos Reis, R.N., da Silva, C.B. and Pereira, J.C.F. (2012) "Vorticity Structures near the Turbulent/Nonturbulent Interface in a Planar Turbulent Jet", 7th International Symposium on Turbulence, Heat and Mass Transfer (THMT), Palermo.
9. J.C.C. Henriques, A.F.O. Falcão, R.P.F. Gomes, L.M.C. Gato. Latching control of an OWC spar buoy wave energy converter. Proc. 31st International Conference Ocean Offshore Arctic Eng., Rio de Janeiro, 2012.
10. A. Veríssimo, R. Oliveira, P. J. Coelho e M. Costa, "Numerical Simulation of a Small-Scale Mild Combustor", 6th European Thermal Sciences Conference, Poitiers - Futuroscope, France, 4-7 de September (2012). In Journal of Physics: Conference Series, Volume 395, 012003 (2012).

9.4.6 New materials, devices, products and processes

9.4.7 Software, computer code and algorithms

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

1. Turbulência em Fluidos, Gulbenkian, 2010 (tradução de a 'First Course in Turbulence' - Tennekes and Lumeley).
2. Coelho, P. J., Costa, M.. Combustão, Edições Orion, 714 pags., Lisboa (1ª Edição, 2007; 2ª Edição, 2012).

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

1. <http://www.thermopedia.com>, P. J. Coelho, "Discrete Ordinates and Finite Volume Methods" (2012).
2. <http://www.thermopedia.com>, P. J. Coelho, "Spatial Discretization Schemes" (2012).
3. <http://www.thermopedia.com>, P. J. Coelho, "Angular Discretization Methods" (2012).
4. <http://www.thermopedia.com>, P. J. Coelho, "Boundary Conditions" (2012).
5. <http://www.thermopedia.com>, P. J. Coelho, "Alternative Formulations" (2012).
6. <http://www.thermopedia.com>, P. J. Coelho, "Ray Effects and False Scattering" (2012).
7. <http://www.thermopedia.com>, P. J. Coelho, "Modified Discrete Ordinates and Finite Volume Methods" (2012).

8. <http://www.thermopedia.com>, P. J. Coelho, "Application to Non-Grey Media" (2012).
9. <http://www.thermopedia.com>, P. J. Coelho, "Variable Refractive Index Media" (2012).
10. <http://www.thermopedia.com>, P. J. Coelho, "Transient Problems" (2012).

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

9.4.17 Organisation of scientific dissemination activities

1. Computational Thermal Radiation in Participating Media III, Eurotherm Seminar No. 83, Lisbon, IST, 15-17 April 2009.
2. 3rd National Conference in Fluid Mechanics, Thermodynamics and Energy, Univ. of Bragança, 17-18 September 2009.
3. ERCOFTAC (European Research Community On Flow, Turbulence, And Combustion), Autumn Festival and Committee Meetings, Lisboa (2010).
4. 10th International Conference on Energy for a Clean Environment (Clean Air 2009), Lisbon, 7-9 July 2009.
5. ECCOMAS Fifth European Conference on Computational Fluid Dynamics, Lisboa (2010).
6. Euromech Colloquium 517 on Interfaces and Inhomogeneous Turbulence, University College London, Inglaterra (2010).
7. Sustainable Island Conference, EU Sustainable Energy Week, EDEN Estoril Hotel, 25-26 March 2010.
8. SPEIC10: Towards Sustainable Combustion, Tenerife, Espanha, 16-18 Junho 2010.
9. Workshop on the oceans as a source of energy. Lisbon, 17-18 May 2010.
10. 11th Int. Conf. on Energy for a Clean Environment, Lisboa (Clean Air 2011).

9.4.18 Research contracts with national or international entities

1. Modelação da dissipação escalar sub-filtro perto da interface turbulenta/nao turbulenta em jactos: aplicações á combustão: UTAustin/CA/0053/2008.
2. IMTT: (Creation of a manual for mechanical training of heavy duty vehicle drivers) Elaboração de Manual de Formação de Motoristas de Veículos Pesados de Passageiros e de Mercadorias, 2008.
3. Development and implementation of a model to optimize routes of waste collection/transportation, 2009/2010, AMARSUL.
4. Experimental Testing of the WaveRoller Wave Energy Device, AW-Energy Oy, Espoo, Finland, 2008-2010.
5. WaveRoller - Wave tank model testing of the WaveRoller device, Transgás, 2009.
6. Armazenagem, SA - Geo-strategic and Economical Assessment of Underground Natural Gas Storage Project in Portugal, 2009
7. REPSOL Monitoring LPG use in heavy-duty diesel vehicles, 2010.
8. Assessment for wave energy resource option for Brunei Darussalem, Powertech, 2010-2011, Contract No. PE 439.
9. Contract No. PE 439, Assessment for wave energy resource option for Brunei Darussalem, Powertech, Canada, 2010-2011.
10. PTO simulator for tank testing of CorPower wave energy device at LH-FEUP, CorPower, Sweden, 2012, Contract No. PE 493.

9.4.19 Projects funded in national and international competitive calls

1. Measurements of air concentration and velocity in Complex Air-Water Flows using a Combined Probe, FCT,

Portugal, Contract N° PTDC/ECM/73867/2006.

2. Arrastamento turbulento: física e simulação das grandes escalas (LES): PTDC/EME-MFE/099636/2008.

3. CORES - Components for Ocean Renewable Energy Systems, FP7-ENERGY-2007-1-RTD, European Commission, 2008-2011, Contract No. 213633.

4. WAVETRAIN 2, Initial Training Network for Wave Energy Research Professionals, FP7-ITN, European Commission, 2008-2012, Grant Agreement No. 215414.

5. Experimental and Numerical Study on Ash Deposit Formation during the Co-Combustion of Coal with Biomass, FCT, Portugal, Contract N° PTDC/EME-MFE/098081/2008.

6. Estudo numérico do acoplamento entre a radiação térmica e a combustão para simulação dos grandes turbilhões em chamas de difusão turbulentas, PTDC/EME-MFE/102405/2008.

7. TURBELAST - Modelos de turbulência para fluidos viscoelásticos: abordagem RANS e LES, PTDC/EME-MFE/113589/2009.

8. Spar-OWC performance testing at NAREC, MARINET 2 FP7 Program, European Commission, 2012, Contract No. 50/2012.

9. Design and experimental testing of a power take-off system for the ANACONDA wave energy conversion device, FCT, Portugal, Contract No. PTDC/EME-MFE/111763/2009.

10. Design of Mooring Systems for Floating Wave Energy Converters, FCT, Contract No. PTDC/EME-MFE/103524/2008.

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The research group on Renewable and Sustainable Energy Systems for the period 2015/2020 comprises around twenty (20) senior researchers (PhD's), and two (2) laboratory technicians.

Currently the group is organized in three (3) sub-groups according to the main research topics, whose scientific activities are coordinated by a senior scientist:

- Mário Costa (Associate Professor with habilitation) heads the research group while simultaneously coordinating the research activities in energy efficiency (including heat transfer and, clean combustion), hydrogen and fuel cells, and energy in transports, including the laboratories facilities.

- José Carlos Pereira (Full Professor) coordinates the research activities in i) turbulence physics and modeling, ii) computational fluid dynamics and, iii) experimental fluid mechanics, including the laboratories facilities.

- Luis Gato (Associate Professor) coordinates the research activities in i) renewable energy and ii) turbomachinery, including the laboratories facilities.

9.5.2 Objectives of the Research Group

The objectives of the research group for the period 2015/2020 will be directed towards developing and improving a range of new and emerging energy technologies and systems including renewable energy, hydrogen and fuel cells, clean combustion techniques, and transportation. This in turn requires the improvement of the present understanding of several fundamental topics in fluid flow, turbulence, heat transfer and combustion. The research work will also continue to contribute to the formation of new generations of Msc and PhD students.

Following the research work carried out within the Renewable and Sustainable Energy Systems in the last years the fundamental research will be focused in turbulence/radiation interactions, turbulence physics and modeling, uncertainly quantification, new computational paradigms, forest fires, and flameless and oxy-fuel combustion. The applied research will be directed towards, co-combustion of coal with biomass, formation of fine particulate matter in biomass combustion; development of turbines for wave energy conversion, development of tools for energy management, and renewable energy technologies, road transportation and industrial biorefineries.

(RG-50022-1625) Engineering Design, Automation and Energy

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1625

9.1.2 Name of the Research Group in portuguese

Engenharia, Projeto, Automação e Energia

9.1.3 Name of the Research Group in English

Engineering Design, Automation and Energy

9.1.4 Keyword(s)

Numerical and experimental methods

Structural integrity

Automation and control systems

Energy and Indoor air quality

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica e Gestão Industrial (INEGI/UP)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
Antonio Augusto Fernandes	Yes	Yes
Renato Manuel Natal Jorge	No	Yes
Abílio Manuel Pinho de Jesus	No	No
Ana Maria Azevedo Neves	No	No
Filipe José Palhares Chaves	No	No
Francisco Manuel Andrade Pires	No	No
Giuseppe Catalanotti	No	No
Jorge Americo Oliveira Pinto Belinha	No	No
Jose Augusto Trigo Barbosa	No	No
Jose Manuel de Almeida Cesar de Sa	No	No
Lucas Filipe Martins da Silva	No	No
Lucia Maria Jesus Simas Dinis	No	No
Marco Paulo Lages Parente	No	No
Maria Fernanda Gentil Costa	No	No
MARIA TERESA DA QUINTA E COSTA MASCARENHAS SARAIVA	No	No
Mariana Doina Banea	No	No
Mariana Rita Ramos Seabra	No	No
Paulo Manuel Salgado Tavares Castro	No	No
Pedro Alexandre Lopes de Sousa Martins	No	No
Pedro Manuel Ponces Rodrigues Castro Camanho	No	Yes
Sónia Liliana da Silva Vieira	No	No
FRANCISCO JORGE TEIXEIRA DE FREITAS	No	No
Alfredo da Silva Ribeiro	No	No
Jose Manuel Mota Couto Marques	No	No

carlos sousa casimiro da costa	No	No
António Manuel Ferreira Mendes Lopes	No	No
Catarina Sofia da Costa Nunes Duarte	No	No
Fernando Gomes de Almeida	No	No
Francisco M. M. C. Vasques Carvalho	No	No
João Pedro Barata da Rocha Falcão Carneiro	No	No
Manuel Rodrigues Quintas	No	No
Manuel Romano dos Santos Pinto Barbosa	No	No
Maria de Fátima Castro Chouzal	No	No
Maria Teresa Braga Valente de Almeida Restivo	No	No
Paulo Augusto Ferreira de Abreu	No	No
Teresa Maria de Serpa Pinto Freitas do Amaral	No	No
Ricardo Angelo Rosa Vardasca	No	No
Carlos Alberto Conceicao Antonio	No	No
Catarina Rosa Santos Ferreira de Castro	No	No
Luisa Maria Pimenta Abreu Costa Sousa	No	No
Maria Luisa Romariz Madureira	No	No
Paulo Alexandre Gonçalves Piloto	No	No
Elza Maria Morais Fonseca	No	No
Luísa Natália da Encarnação Hoffbauer	No	No
Eduardo Guimaraes de Oliveira Fernandes	No	No
Gabriela Ventura Alves da Silva	No	No
Vítor Manuel da Silva Leal	No	No
Sofia-Natalia Boemi	No	No
Vasco Manuel Ferreira Tameirão Montenegro Granadeiro	No	No
Joaquim Gabriel Magalhães Mendes	No	No
Carla Maria da Cunha Roque	No	No

9.2.2 List of current PhD students

NAME

Thuane Huyer da Roza
Fernanda Sofia Quintela da Silva Brandão
Helder Tiago Carriço Mata
Carolina Ana Garbe
Luana Souto Barros
Nilza Alexandra Gomes Ramião
Rita Rynkevic
Dulce Alves de Oliveira
Maria Elisabete Teixeira Da Silva
Carla Bibiana Monteiro França Santos
Daniel Francisco Barros Marinho Esteves Pina
Daniel Filipe Oliveira Braga
Seyed Mohsen Mirkhalaf Valashani

Daniel Filipe Coutinho Peixoto
Paulo Henrique Carvalho Iglesias Neves
Ana Sofia Oliveira Queirós Ferreira Barbosa
Eduardo André de Sousa Marques
Ricardo João Camilo Carbas
Susana Fernandes Moreira
Tiago Faustino Andrade
Rita Alexandra Couto Soares Guerra
Zafeiris Kokkinogenis
António José Ramos Silva
Fernando Manuel da Silva Ribeiro
Silvio Costa Sampaio
Rodrigo Lange
Carlos Manuel Dias Viegas
Erico Meneses Leão
Mara da Silva Benedito Martins
Benedito Rodrigues Bitencort Junior
Francisco José Jerónimo de Almeida
Sara Moreira Coelho de Magalhães
Mariana Abrunhosa de Carvalho Martins Pereira
Nathan Coenen Lee
Marcelo Bruno Serrão Fontes Parente da Costa
Rosa Maria Moreira de Paiva
Robson Costa
Fábio José Pinho Reis
Thiago de Carvalho Rodrigues Doca
shenghua wu
Igor André Rodrigues Lopes
Fernando Pala Beirão Macedo
Joana Georgete Vieira Madureira
Guilherme Miranda Silva de Oliveira Viana
José António Fonseca de Oliveira Correia
António Luís Lima da Silva
João Carlos Rego Pereira
Christian Wimmmler
Golnar Hejazi
Mafalda Leite de Faria Coelho da Silva
Carlos Miguel Correia Albuquerque
Lúcio Sanchez Passos
Maria Goreti Antunes Fernandes

9.2.3 List of other researchers of the Research Group

NAME

João Manuel Brasileiro Monteiro
Maria Teresa Coelho Dias Arede
Antonio Jose Pessoa de Magalhaes
Carlos Manuel De Sousa Moreira da Silva
Susana Daniela da Silva Martins
Ana Isabel Martins Casal Ramos
Isabel Filipa Martins Ferreira
Hélder Filipe Sousa Gomes Pereira
Inês Ribeiro Paciência
Isabel Maria Gonçalves Azevedo
Rui Pedro Moreira Correia
Renato de Azevedo rodrigues
João Pedro Sousa Ferreira
Paulo Alexandre Gomes Gonçalves da Rocha
Isabel Maria Baltazar Simões de Carvalho da Fonseca
Bruno Filipe Rodrigues Bento dos Santos
Miguel Augusto Vigario de Figueiredo
José Carlos Marques Rodrigues
Cristina Maria Clementino Fernandes de Faria Miranda Guedes

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

Characterization of the group

During the period of 2008-2012 the group has been hosted at IDMEC (Institute of Mechanical Engineering) whose stakeholders are the University of Porto through the Faculty of Engineering and Technical University of Lisbon through the IST (Technical Institute).

The group is composed by 51 doctorate members, 53 PhD students and 19 other collaborators. Most of the PhD researchers are faculty members of University of Porto (Faculty of Engineering, Faculty of Medicine and Faculty of Nutrition and Food Sciences) but members from other higher educational institutions of the north of Portugal such as University of Trás-os-Montes and Alto Douro, Bragança Polytechnic Institute and Porto Polytechnic Institute also integrate the group.

12 of PhD researchers have a post-doc grant or a position as researcher. The PhD students have different backgrounds, covering a large number of research topics. The students are enrolled in various doctoral programs: Mechanical Engineering, Sustainable Energy Systems, Biomedical Engineering, MIT Portugal Leaders for Technical Industries, Electrical and Computer Engineering, Computer Engineering, etc.).

Structure of the group

The group is organized in 4 subgroups:

- Advanced Studies on Energy in the Built Environment
- Design and Experimental Validation
- Numerical Methods in Mechanical and Structural Engineering
- Systems Integration and Process Automation

The subgroup 'Advanced Studies on Energy in the Built Environment', has developed its activity, with recognized success, in two main areas: Built environment and Energy planning. The first one is related with indoor air quality (IAQ), including the establishment of criteria and strategies for IAQ, development of innovative measurement techniques, efficient characterization of materials and audit procedures. As far as energy planning is concerned the focus has been and will be on studies covering energy efficiency and its management.

The 'Design and Experimental Validation' (UCVE) subgroup main lines of research cover computational biomechanics, structural integrity of components and structures, manufacturing processes, transport equipment, product innovation methodologies, computational methods and numerical modelling. Knowledge relevant for sectors as aeronautics and aerospace, surface transportation (railways, road buses, cars and freight vehicles and shipbuilding) and biomedicine has been developed. Current drivers for innovation are sustainability and cost reduction and performance enhancement.

The subgroup of 'Numerical Methods in Mechanical and Structural Engineering' research and development activities cover different areas and topics, namely: reliability and optimal design of structures in mechanical engineering; numerical simulation and optimization of industrial forming and machining processes; development of evolutionary algorithms and hybridization of optimization techniques; modeling, simulation and optimization in bioengineering applications.

The subgroup of 'System Integration and Process Automation' activities are focused on advanced methodologies for decentralized motion control systems involving an intersection among the fields of control engineering, real-time communications, advanced transducers for bio-engineering/health and industrial applications. The interaction between control systems and health sciences has been producing visible results, with clear progress either in advanced motion control architectures, in real-time communications and in new transducers for engineering, bio-engineering, medical and nutritional applications, including reliable wireless communication.

9.3.2 Main achievements

The overall scientific outcomes of the group can be summarized as follows:

- Research Projects contracted with European or national agencies: 37 projects were running each year in the period, on average, representing more than 4 million euros of funds
- Publications: during the period members of the group (average 51 doctorate members) published 54 books, 373 papers in refereed international journals, 766 papers in refereed international conferences
- Training of young researchers: 199 MSc Thesis and 33 PhD thesis were completed; at the end of 2012 there were 51 PhD thesis in progress (many of them funded by research projects in progress)
- Editorial activity: 4 members were guest editors, and 4 members integrated the editorial board of international journal and 1 member is editor of an ISI referenced international journal

Main achievements of the group (not comprehensive) during the period 2008-2012 are summarized below:

- Major role in the definition of the framework for establishing future EU policies for indoor air quality, through projects like ENVIE and Healthvent.
- Development of tools to support integrated energy and/or carbon abatement plans at municipal or regional levels, which are now being used in practice.
- Significant contribution to the advancement of knowledge in the rationale for defining design options for Net-Zero Energy buildings.
- Development of efficient computational mechanics tools, validated by experimentation, for metallic and composite structures.
- Criteria for damage modeling and failure for metallic and advanced composites structures.
- Damage tolerance criteria for lightweight integral monolithic structures.
- Establishment of original criteria for design of advanced composite structures, and novel concepts for buses structures using lightweight materials.
- Tools and procedures for optimal design of adhesive bonded joints of both metallic and composites structures and multimaterials joints.
- Derivation of mechanical properties of soft tissues and numerical modeling of soft tissues and organs.
- Internationally recognized contribution for the advancement of knowledge of the biomechanics of the female pelvic cavity and in particular the biomechanics of vaginal delivery.
- Proposal of real-time communication mechanisms adequate for IEEE 802.11e networks operating in open communication environments disturbed by uncontrolled traffic sources.
- Development of a new digital laryngoscope prototype for tracheal intubation.
- Development of a portable and non-invasive system to assess the body fat percentage by measurement of the skinfold thickness.
- A prototype was developed to demonstrate the potentialities achieved with the nonlinear control laws developed at the group. The system is composed by standard pneumatic components and has the ability to perform positioning tasks with an error of $\pm 1\mu\text{m}$ (the encoder resolution), with any mass ranging from 2kg to 13kg in any arbitrary position of the cylinder stroke.
- Development of a hyper-intensive fish farming concept for lasting competitiveness and superior production.
- Development of a hand grip dynamometer for nutritional assessment.
- Development of tangible user interfaces for training purposes.
- Developments in online experimentation.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

1. Lucas F M da Silva, Paulo J C das Neves, R D Adams, J K Spelt, "Analytical models of adhesively bonded joints - Part I: Literature survey", International Journal of Adhesion and Adhesives, 29:319-330, 2009 (journal impact factor=1.295, number of citations ISI=98, average citations per year=19.60, most cited article of this journal published since 2008).

2. Lucas F M da Silva, Paulo J C das Neves, R D Adams, J K Spelt, "Analytical models of adhesively bonded joints - Part II: Comparative study", *International Journal of Adhesion and Adhesives*, 29:331-341, 2009 (journal impact factor=1.295, number of citations ISI=64, average citations per year=12.80).
3. MT Restivo, J Mendes, AM Lopes, CM Silva, MF Chousal, "A Remote Laboratory in Engineering Measurement", *IEEE Transactions on Industrial Electronics*, 56:4836-4843, 2009 (journal impact factor=4.678, number of citations=42, average citations per year=8.60).
4. A Turon, PP Camanho, J Costa, J Renart, "Accurate simulation of delamination growth under mixed-mode loading using cohesive elements: definition of interlaminar strengths and elastic stiffness", *Composite Structures*, 92:1857-1864, 2010 (journal impact factor=2.036, number of citations ISI=34, average citations per year=8.5).
5. Z Ma, JMRS Tavares, RM Natal Jorge, T Mascarenhas, "A review of algorithms for medical image segmentation and their applications to the pelvic cavity", *Computer Methods in Biomechanics and Biomedical Engineering*, 13:235-246, 2010 (journal impact factor=1.573, number of citations ISI=33, average citations per year=8.25).
6. B Calvo, E Peña, PALS Martins, T Mascarenhas, M Doblaré, RM Natal Jorge, AJM Ferreira, "On modeling damage process in vaginal tissue", *Journal of Biomechanics*, 42:642-651, 2009 (journal impact factor=2.657, number of citations ISI=24, average citations per year=4.80).
7. A Neves, V Leal, "Energy sustainability indicators for local energy planning: Review of current practices and derivation of a new framework", *Sustainable Energy Reviews*, 14:2723-2735, 2010 (journal impact factor=5.627, number of citations=22, average citations per year=5.50).
8. JP Santos, M Oliveira, FG Almeida, JP Pereira, A Reis, "Improving the environmental performance of machine-tools: influence of technology and throughput on the electrical energy consumption of a press-brake", *Journal of Cleaner Production*, 19:356-364, 2011 (journal impact factor=2.71, number of citations=21, average citations per year=7.00).
9. CC António, LN Hoffbauer, "An approach for reliability-based robust design optimisation of angle-ply composites", *Composite Structures*, 90:53-59, 2009 (journal impact factor=2.006, number of citations ISI=10).
10. MPL Parente, RM Natal Jorge, T Mascarenhas, AL Silva-Filho, "The influence of pelvic muscle activation during vaginal delivery: computational model", *Obstetrics and Gynecology*, 115:804-808, 2010 (journal impact factor=4.392).

9.4.2 Completed PhD theses

1. Marco Paulo Lages Parente, "Biomechanics of the Pelvic Floor during Vaginal Delivery", Institution degree award: FEUP (PhD in Mechanical Engineering), Supervisor: RM Natal Jorge (FEUP), Co-supervisors: T Mascarenhas (FMUP), JAC Martins (IST).
2. Valentin Richter-Trummer, "Residual stress effects and damage tolerance behavior of integral lightweight structures manufactured by FSW and MSM", Institution degree award: FEUP (Ph.D. in Mechanical Engineering), Supervisor: PTCastro (FEUP), Co-supervisors: Jorge F. dos Santos (HZG, former GKSS), Pedro Vilaca (IST), Industrial supervisor: Marco Pacchione (AIRBUS, Hamburg).
3. Filipe Andrade Xavier Costa, "Non-local Modelling of Ductile Damage: Formulation and Numerical Issues", Institution degree award: FEUP (Ph.D. in Mechanical Engineering), Supervisor: José César de Sá (FEUP), Co-supervisor: FM Andrade Pires (FEUP).
4. Carlos Casimiro Costa, "Design for Sustainability. The engineering of the new living landscape", Institution degree award: FEUP, Supervisor: AA Fernandes (FEUP), Co-supervisor: H Fabião.
5. Mariana Seabra Rita Ramos, "Continuous-discontinuous Approach for the Modelling of Ductile Fracture", Institution degree award: FEUP (Ph.D. in Mechanical Engineering), Supervisor: José César de Sá (FEUP).
6. Pedro Silva, "Influence of control patterns for lighting and shading systems on the predicted energy performance of buildings", Institution degree award: FEUP (Ph.D. in Sustainable Energy Systems of the MIT Portugal program), Supervisor: V Leal (FEUP).
7. Maria Kapsalaki, "Efficient Design of Net-zero Energy Buildings with respect to local context", Institution degree award: FEUP (Ph.D. in Sustainable Energy Systems of the MIT Portugal program), Supervisor: V Leal (FEUP), Co-supervisor: Matheos Santamouris (N. K. University of Athens).
8. Valério Rosset, "Services for Safety-Critical Applications on Dual-Scheduled TDMA Networks", Institution degree award: FEUP (PhD thesis in Electrical and Computer Engineering), Supervisor: Pedro Souto (FEUP), Co-supervisor: Francisco Vasques (FEUP).
9. Patrick Loschmidt, "On Enhanced Clock Synchronization Performance Through Dedicated Ethernet Hardware Support", Institution degree award: Technical University of Vienna, Austria (PhD thesis in Computer Engineering), Supervisor: Thilo Sauter (Donau-Universität Krems, Austria), Co-supervisor: Francisco Vasques (FEUP).
10. Nadja Mench Bressan, "Integrated Anaesthesia Software: Data Acquisition, Controlled Infusion Schemes and Intelligent Alarms", Institution degree award: FEUP (PhD thesis in Biomedical Engineering), Supervisor: Catarina Sofia da Costa Nunes Duarte (King's College London), Co-supervisor: António Paulo Moreira (FEUP).

9.4.3 Patents and Prototypes or other research outputs

1. Maria Teresa Restivo, Fernando Gomes de Almeida, Joaquim Mendes, "Transdutor de deslocamento baseado em

- sensores de fluxo magnético" ("Displacement transducer based in magnetic flux sensors"), PT 103546, May 2008.
2. Maria Teresa Restivo, Teresa Amaral, Joaquim Gabriel Mendes, Manuel Quintas and Fátima Chouzal, "Dispositivo para aquisição e processamento de dados para determinação da massa corporal" ("Device for Monitoring, Digital Recording and Assessing Body Composition"), PT 103 721, December 2009.
 3. Joaquim Mendes, Ana Pereira, Adélio Mendes, Luis F. Melo, Método e Dispositivo de Medição e Identificação de Biofilmes Usando Vibrações, Application n. 29089, INPI, filled on September 9, 2009. Assignee to University of Porto. National Patent n. 103344, published in the Intellectual Property Bulletin 95/2008, May 15, 2008.
 4. José Lima, Joaquim Mendes, "Sistema Linear para a Movimentação de Veículos" ("Linear System for Moving Vehicles"), Application n. 1000055740, INPI, filled on June 8, 2009. Assignee to University of Porto. National Patent n. 104642, published in the Intellectual Property Bulletin, December 9, 2010, PCT Extension: "Device for propelling vehicles", Application number WO2010PT00022 20100531, Patent n. WO2010143987 (A1) ? December 16, 2010.
 5. Joaquim Mendes, Jorge Reis, João Tavares, Georgeta Oliveira, José Soeira, "Otoscópio digital" ("Digital otoscope"), Application n. PT 3337, INPI, filled on July 14, 2008, National Patent n. 104131, published in the Intellectual Property Bulletin, January 14, 2010. Commercial agreement with the Metablue company, PCT Extension: "Device for measuring and analysing the colour of the outer ear and ear canal", Application number WO2012IB51376 20120322, Patent n. WO2010008310 (A2) ? January 21, 2010.
 6. Adélio Mendes, Joaquim Mendes, Helena Ribeiro, Michael Grätzel Luísa Andrade, Luís Gonçalves, Carlos Costa, Processo de Selagem com Vidro de Células Solares DSC, Application n. 1000103837, INPI, filled on December 5, 2008. Assignee to University of Porto. National Patent n. 104282, published in the Intellectual Property Bulletin, June 7, 2010, PCT Extension: "Glass based sealing of Dye Sensitized Solar Cells", Application number WO2009IB55511 20091204, Patent n. WO2010064213 (A1) ? June 10, 2010.
 7. João Carlos Pinho, Miguel Pais Clemente, Joaquim Gabriel Mendes, Mario Augusto Pires Vaz, "Dispositivo Intra-Oral Para A Prevenção de Traumatismos Orofaciais Decorrentes Da Prática Desportiva" (Intra-Oral Device for The Prevention of Orofacial Injuries Arising From Sport Practice), Application n. 20101000086098, INPI, filled on November 11, 2010. Assignee to University of Porto. National Patent n. 105379, published in the Intellectual Property Bulletin, May 11, 2012.
 8. Adélio Mendes, Luisa Andrade, Joaquim Mendes, Jose Nogueira, Fernando Ribeiro, "Substrate and electrode for solar cells and the corresponding manufacturing process" (Substrato e eléctrodo para células solares e respectivo processo de fabrico), Application n. PT 20111000022852, INPI, filled on March 22, 2011. Assignee: EFACEC - ENGENHARIA, S.A. National Patent n. 105578, published in the Intellectual Property Bulletin, September 24, 2012.
 9. Adélio Mendes, Luisa Andrade, Joaquim Mendes, Jose Nogueira, Fernando Ribeiro, Células solares, seus módulos e seu processo de fabrico (Solar cells, their modules and fabrication process), Application n. PT20111000022894, INPI, filled on March 22, 2011. Assignee to EFACEC - ENGENHARIA, S.A. National Patent n. 105579, published in the Intellectual Property Bulletin, September 24, 2012.
 10. Joaquim Gabriel Mendes, António Ramos Silva, Pedro de Pinho e Costa Amorim, Manuel Rodrigues Quintas, Renato Manuel Natal Jorge, Laringoscópio Digital, Referência UPIN PAT. 127/12.

9.4.4 Books and book chapters of international circulation

1. PP Camanho, ST Pinho, CG Dávila, JJC Remmers, Mechanical Response of Composites, within Book Series 'European Community on Computational Methods in Applied Sciences (ECCOMAS) Series', Springer, ISBN 978-140-2085-83-3, 2008.
2. Lucas FM da Silva, Andreas Öchsner (Editors), Modeling of adhesively bonded joints, Springer, Heidelberg, 2008.
3. EO Fernandes, L Meeus, V Leal, I Azevedo, E Delarue, JM Glachant, Smart Cities Initiative: How to Foster a Quick Transition towards Local Sustainable Energy Systems, final report of the topic 'Smart Cities' from the FP7 project THINK - Advising the EC (DG ENERGY) on Energy Technology Policy, ISBN 978-92-9084-068-8, 2011.
4. RM Natal Jorge, João Manuel RS Tavares, Marcos Pinotti, Alan Slade, Technology and Medical Sciences, Taylor & Francis, ISBN 978-0-415-66822-4, 2011.
5. PP Camanho, L Tong (Editors), Composite joints and connections: principles, modelling and testing, Woodhead Publishing Ltd., Cambridge, UK, ISBN 978-1-84569-990-1, 2011.
6. Lucas FM da Silva, David Dillard, Bamber Blackman, RD Adams, Testing adhesive joints - Best practices, Wiley, Weinheim, ISBN 978-3-527-32904-5, 2012.
7. MT Restivo, FG Almeida, MF Chouzal, Strain Measurement, within Book Series 'Measurement of Physical and Chemical Quantities', International Frequency Sensor Association (IFSA) Publishing, ISBN: 978-84-615-9897-7, 2012.
8. RM Natal Jorge, João Manuel RS Tavares, Marcos Pinotti, AP Slade, Technologies for Medical Sciences, within Book Series 'Lecture Notes in Computational Vision and Biomechanics', Vol.1, Springer, ISBN 978-94-007-4068-6, 2012.
9. Lucas FM da Silva, Preparing bulk specimens by hydrostatic pressure, in: 'Best practices in preparing and testing adhesive joints', Lucas FM da Silva, D Dillard, B Blackman, RD Adams (Editors), Wiley, Weinheim, 2012.
10. CA Roulet, PM Bluysen, B Muller, EO Fernandes, Design of Healthy, Comfortable and Energy-Efficient Buildings, (Chapter 6) in: 'Sustainable Environmental Design in Architecture, Impacts on Health', S.T. Rassia and P.M. Pardalos

9.4.5 Conference proceedings

1. JAFO Correia, AMP Jesus, MAV Figueiredo, AS Ribeiro, AA Fernandes, "Variability Analysis of Fatigue Crack Growth Rates of Materials from Ancient Portuguese Steel Bridges", 4th International Conference on Bridge Maintenance, Safety and Management - IABMAS'08, Seoul, Korea, 13-17 July 2008.
2. LFM da Silva, EAS Marques, "Stress analysis and failure properties of adhesively bonded patches", Indo-Swiss Bonding 2008, Chromepet Chennai, Índia, 14-16 February 2008.
3. PP Camanho, A Turon, J Costa, "Simulation of delamination under high cycle fatigue using a cohesive zone model", 9th World Congress on Computational Mechanics, Sydney, 2010.
4. MD Banea, LFM da Silva, RDSG Campilho, "Effect of temperature on mode II fracture toughness of adhesively bonded joints", 11th Triennial International Conference on the Science and Technology of Adhesion and Adhesives, York, UK, 7-9 September 2011.
5. R Costa, P Portugal, F Vasques, R Moraes, R Custódio, "A Coordination Layer to Handle Real-Time Communication in Wi-Fi Networks with Uncontrolled Traffic Sources", 36th IEEE Conference on Local Computer Networks (LCN-2011), Bonn, Germany, 4-7 October, 2011.
6. EO Fernandes, S Kephelopoulos, M Jantunen, P Carrer, D Kotzias, G Gallo, M Fuchs, "From Knowledge To Action: Giving Birth to a New Framework on IAQ Related Policies Indoor Air", Proceedings of the 12th International Conference on Indoor Air Quality and Climate, Paper No. 824, Austin, Texas, 5-10 June, 2011.
7. O Seppänen, W Bischof, N Brelih, V Leal, P Wargocki, "Ventilation guidelines based on real world indoor air quality and ventilation related problems (prescriptive guidelines)", Proceedings of the Healthy Buildings 2012 conference, Brisbane, Australia, 8-12 July 2012.
8. R Fazeli, V Leal, JP Sousa, "A New Approach to Design Policies for the Adoption of Alternative Fuel-Technology Powertrains", Proceedings of the International Conference on Sustainable Urban Transport and Environment, Amsterdam, Netherlands, 13-14 May, 2012.
9. J Belinha, LMJS Dinis, RM Natal Jorge, "A new meshless method applied to the analysis of 3D structures", 6th European Congress on Computational Methods in Applied Sciences and Engineering ECCOMAS 2012, Abstract #2211, CD-ROM, J Eberhardsteiner et al. (Eds.), Vienna, Austria, 10-14 September 2012.
10. H Mata, RM Natal Jorge, A Santos, MPL Parente, RAF Valente, AA Fernandes, "Numerical modeling and experimental study of sandwich shells with metal foam cores", in the conference proceedings of The 15th International ESAFORM Conference on Material Forming, CD-ROM pp.449-454, Erlangen, Germany, 14-16 April, 2012.

9.4.6 New materials, devices, products and processes

1. Manuel Rodrigues Quintas, Carlos Moreira da Silva, Tiago Faustino Andrade, Maria Teresa Restivo, Fátima Chouzal, Teresa Freitas do Amaral, "Adipsmeter 3.3 - Dispositivo para Medição da Espessura de Pregas Cutâneas" (Wrinkle Depth Measuring Device).
2. Fernando Gomes de Almeida, João F. Carneiro, "Portable Servopneumatic Device".
3. Manuel Rodrigues Quintas, Carlos Moreira da Silva, Tiago Faustino Andrade, Maria Teresa Restivo, Fátima Chouzal, Teresa Freitas do Amaral, "Adipsmeter V4".
4. Manuel Rodrigues Quintas, Carlos Moreira da Silva, Tiago Faustino Andrade, Maria Teresa Restivo, Fátima Chouzal, Teresa Freitas do Amaral, "Adipsmeter V2 - Dispositivo para Medição da Espessura de Pregas Cutâneas".
5. Joaquim Gabriel Mendes, "Arm stand automation system".
6. Orlando Frazão, Luís Coelho, JL Santos, J C. Marques, M.T. Restivo, "New optical fiber pressure sensor & calibration system".
7. Joaquim Gabriel Mendes, "PID demo desktop workbench control".
8. Maria Teresa Restivo, Joaquim Mendes, Eva Barreira, Vasco Teixeira de Freitas, "New online Metrological Station".
9. Manuel Rodrigues Quintas, Paulo Abreu, "Adjustable compliance device for integration into robotic grinding applications".
10. Joaquim Gabriel Mendes, Pedro Amorim, Manuel Rodrigues Quintas, Renato Natal Jorge, António Silva, Joana Teixeira, "Digital Laryngoscope".

9.4.7 Software, computer code and algorithms

1. Ana Rita Neves, Software "LEPA: Local Energy Planning Assistant".
2. Maria Kapsalaki, "Software for Economic optimization of Net-zero energy buildings design".
3. PingJung Xia, António Mendes Lopes, Maria Teresa Restivo, "AVAE - Haptics Based Virtual Assembly

Environment".

4. Joaquim Mendes, "Laryngo Monitor V2".

5. Tiago Faustino Andrade, Manuel Rodrigues Quintas, Maria Teresa Restivo, Fátima Chouzal, Teresa Freitas do Amaral, Carlos Moreira da Silva, "Liposoft 2011".

6. José Couto Marques, António A. Sousa, Filipe Castro, João Paulo, Maria Teresa Restivo, "SoftBeam" (virtual reality application).

7. Joaquim Mendes, António Viana Fonseca, "3D soil cubic test bench".

8. António Mendes Lopes, Maria Teresa Restivo, "Virtual/Real Haptic Device".

9. Maria Teresa Restivo, António Mendes Lopes, "Haptic Interaction with Remote & Virtual Experiment".

10. T Pereira, A Sousa, A Lopes, Maria Teresa Restivo, "Framework for developing virtual experiments with haptic interaction".

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

1. Lucas FM da Silva, Teresa Duarte, Viriato Antunes, "Problemas e trabalhos práticos de metalurgia mecânica" (in portuguese), FEUP edições, Porto, ISBN 978-972-752-086-2, 2008.

2. Lucas FM da Silva, Joaquim Silva Gomes, "Introdução à resistência dos materiais" (in portuguese), Publindústria, Porto, ISBN 9789728953553, 2010.

3. DA Ferreira, L Antunes, P Amorim, C Nunes (authors), "Recent Advances in BIS Guided TCI Anesthesia", Nova Science Publishers, New York, ISBN 978-1-61668-627-7, 2010.

4. António Pessoa de Magalhães, "Práticas de Automação Industrial: especificação e programação de soluções de controlo lógico no ambiente de treino ITS PLC" (in portuguese), Real Games Lda, Porto, ISBN 978-989-96460-0-1, 2010.

5. Maria Teresa Restivo, Fernando Gomes de Almeida, Maria de Fátima Chouzal, Joaquim Gabriel Mendes, António Mendes Lopes, "Handbook of Laboratory Measurements and Instrumentation", International Frequency Sensor Association (IFSA) Publishing, Barcelona, ISBN 978-84-615-1138-9, 2011.

6. Lucas FM da Silva, Design rules and methods to improve joint strength, in: 'Handbook of Adhesion Technology', LFM da Silva, A Öchsner, RD Adams (Editors), Springer, Heidelberg, 978-3-642-01168-9 2011.

7. Lucas FM da Silva, Raul DSG Campilho, "Advances in numerical modelling of adhesive joints", Springer, Heidelberg, ISBN 978-3-642-23607-5, 2012.

8. Lucas FM da Silva, "Comportamento mecânico dos materiais" (in portuguese), Publindústria, Porto, ISBN 978-989-723-024-0, 2012.

9. José Augusto Trigo Barbosa, "Noções sobre Álgebra Linear" (in portuguese), Coleção Manual, FEUP Edições, 1ª Edição, ISBN 978-972-752-142-5, 2012.

10. Maria Teresa Restivo, Fernando Gomes de Almeida, Maria de Fátima Chouzal, Strain Measurement (Book Series: Measurement of Physical and Chemical Quantities), International Frequency Sensor Association (IFSA) Publishing, ISBN: 978-84-615-9897-7; July 2012.

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

1. João MRS Tavares, RM Natal Jorge (Guest Editors), Special issue on "Image Processing and Analysis in Biomechanics", Journal on Advances in Signal Processing, 2009.

2. Maria Teresa Restivo, Special Issue: IRF'09, International Journal of Online Engineering, Vol. 5, 2009.

3. PMST de Castro, G Guinea (Guest Editors), Special issue: Iberian Conference on Fracture and Structural Integrity - CIFIE'2010, International Journal of Structural Integrity, vol. 1(4), 2010.

4. Lucas FM da Silva, Andreas Öchsner, RD Adams (Guest Editors), Special issue on "Durability of adhesive joints", Journal of Adhesion Science and Technology, 2012.

5. Lucas FM da Silva, Andreas Öchsner, RD Adams (Guest Editors), Special issue on "Joint design 3", International Journal of Adhesion and Adhesives, 2012.

6. Lucas FM da Silva, Andreas Öchsner, RD Adams (Guest Editors), Special issue on "Adhesive properties and adhesion", The Journal of Adhesion, 2012.

7. Andreas Öchsner, Lucas FM da Silva, H Altenbach (Guest Editors), Special Edition (ACE-X 2011) on "Advanced Computational Engineering and Experimenting", Materialwissenschaft und Werkstofftechnik, 2012.

8. João MRS Tavares, RM Natal Jorge (Guest Editors), Special issue on "Image Processing", International Journal of Tomography & Statistics, 2010.

9. Maria Teresa Restivo, A Cardoso (Guest Editors), Special issue on "exp.at'11", International Journal of Online Engineering, 2012.

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

1. PMGP Moreira, V Richter-Trummer, PMST de Castro, "Fatigue behaviour of FS, LB and MIG welds of AA6061-T6 and AA6082-T6", invited book chapter, in: 'Multiscale Fatigue Crack Initiation and Propagation of Engineering Materials - Structural Integrity and Microstructural Worthiness', George C Sih (Editor) Springer Science + Business Media BV, ISBN 978-1-4020-8520-8, 2008.
2. A Turon, J Costa, PP Camanho, P Maimí, "Analytical and numerical investigation of the length of the cohesive zone in delaminated composite materials", in: 'Mechanical Response of Composites', PP Camanho, CG Dávila, ST Pinho, J Remmers (Editors), Springer, ISBN 978-140-2085-83-3, 2008.
3. A Öchner, LFM da Silva, RD Adams, "Complex joint geometry", in: 'Modelling of adhesively bonded joints', Lucas FM da Silva, Andreas Öchsner (Editors), Springer, Heidelberg, ISBN 978-3-540-79055-6, 2008.
4. LMJS Dinis, RM Natal Jorge, J Belinha, "The radial natural neighbour interpolators extended to elastoplasticity", in: 'Progress on Meshless Methods', Computational Methods in Applied Sciences Series, Vol.13, AJM Ferreira, EJ Kansa, GE Fasshauer, VMA Leitão (Editors), Springer, ISBN 978-1-4020-8820-9, 2009.
5. MT Restivo, "On the use and promotion of Remote Labs in Portugal: A Personal Commitment", in: 'Using Remote Labs in Education, Two Little Ducks in Remote Experimentation', JG Zubía, GR Alves (Editors), ISBN 978-84-9830-335-3, 2011.
6. LMJS Dinis, RM Natal Jorge, J Belinha, "The dynamic analysis of thin structures using a radial interpolator meshless method", in 'Vibration and Structural Acoustics Analysis', Computational Methods in Applied Sciences Series, CMA Vasques, J Dias Rodrigues, (Editors), Springer, ISBN 978-94-007-1703-9, 2011.
7. LFM da Silva, "Quasi-static testing of lap joints", in: 'Best practices in preparing and testing adhesive joints', Lucas F M da Silva, David Dillard, Bamber Blackman, R D Adams (Editors), Wiley, Weinheim, ISBN 978-3-527-32904-5, 2012.
8. LFM da Silva, "Dynamic mechanical analysis", in: 'Best practices in preparing and testing adhesive joints', Lucas F M da Silva, David Dillard, Bamber Blackman, R D Adams (Editors), Wiley, Weinheim, ISBN 978-3-527-32904-5, 2012.
9. V Richter-Trummer, PMGP Moreira, PMST de Castro, "Damage tolerance of aircraft panels taking into account residual stress", in: 'Structural connections for lightweight metallic structures', PMGP Moreira, LFM da Silva, PMST de Castro (Editors), Springer, ISBN 978-3-642-18187-0, 2012.
10. LFM da Silva, "Technology of mixed adhesive joints", in: 'Hybrid adhesive joints', LFM da Silva, A Pirondi, A Öchsner (Editors), Springer, Heidelberg, ISBN 978-3-642-16622-8, 2011.

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

1. J Belinha, "Do you know that is possible to predict the bone tissue remodelling?", in the scope of the scientific dissemination program 'Engenharia num Minuto' ('Engineering in one Minute'), 2012.
2. M Parente, "Did you know it's already possible to see the birth of your child even before it happens?", in the scope of the scientific dissemination program 'Engenharia num Minuto' ('Engineering in one Minute'), 2012.
3. P Martins, "Did you know that certain physiological changes in the human body as aging, imply changes in the mechanical properties of tissues?", in the scope of the scientific dissemination program 'Engenharia num Minuto' ('Engineering in one Minute'), 2012.
4. RM Natal Jorge, "Did you know that the use of metal foams in automotive can reduce the number of fatalities in road accidents?", in the scope of the scientific dissemination program 'Engenharia num Minuto' ('Engineering in one Minute'), 2012.
5. V Freitas, E Barreira, MT Restivo, "Meteorological Station of LFC/FEUP", produced by Joana Quintela. Available for general public at <http://paginas.fe.up.pt/~expat/experimentaportugal/laboratorios.php?lang=en>
6. J Couto Marques, MT Restivo, V Trigo, "Earth Dam Disaster", produced by Joana Quintela. Available for general public at <http://paginas.fe.up.pt/~expat/experimentaportugal/laboratorios.php?lang=en>
7. MT Restivo, T Andrade, "A New Skinfold Caliper", produced by Joana Quintela. Available for general public at http://paginas.fe.up.pt/wwwidmec/uispa/sensors_actuators.php (LopoTool - Mechanical Design of a new Calliper)
8. F Gomes de Almeida, J Carneiro, "Modelling and Control of a Servopneumatic systems control", produced by Joana Quintela. Available for general public at http://paginas.fe.up.pt/wwwidmec/uispa/sensors_actuators.php
9. Antonio Augusto Fernandes, "Acidentes de autocarros?", in science dissemination program 'Engenharia num Minuto' ('Engineering in one Minute'), FEUP, 2012.
10. Antonio Augusto Fernandes, "Inovação na Engenharia?", in science dissemination program 'Engenharia num

Minuto' ('Engineering in one Minute'), FEUP,2012.

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

1. experiment@Portugal, <http://www.fe.up.pt/experimentaportugal>, makes available the national potential in online experimentation based in the remote and virtual Labs of higher education institutions in Portugal, which are available in the platform pt.lab2go. This website received the Honorable Mention, Blended Learning, 2012, http://www.ielassoc.org/awards_program/past_winners_AD_2012.html, from the International E-Learning Association (IELA)
2. pt.lab2go (<http://pt.lab2go.net>) offers the national resources in online experimentation in an unified way, being the Portuguese version of the lab2go (<http://www.lab2go.net/>). Lab2go supports the Global Online Laboratory Consortium (<http://online-lab.org/>)

9.4.15 Performances and exhibitions to the extent that they embody research

1. 1st Place on 5th "eLearning in Praxis" Competition Slovakia & 2008, 1st Place on Zon Multimedia National Competition (M. T. Restivo, F. G. Almeida, M. F. Chouzal, J. G. Mendes, A. M. Lopes, Instrumentation for Measurement: a Unique e-Book)
2. Programa Ciencia 2010, RTP2, "first ebook with free access to FEUP LABs", 10 July 2008
3. Technology offer, EDAM course, 7 March 2008
4. Researchers night, % of Body fat evaluation, September 2008
5. "A new bicycle transmission system" and a "Digital Otoscope", Innovation Days, 4^{as} Jornadas de Inovação, Parque das Nações, Lisboa, 18-20 June 2009
6. Health Innovation & Technology Transfer Showcase, Health Cluster Portugal, 2011
7. 40th Salon International des Inventions Genève, 2012
8. Technologies Showroom, BIN@PORTO, 2012
9. "Monitoring and control platform for labs", included in the BIN@PORTO2012 event, Open Day of UPTEC Innovation Centre, October 24-26, 2012
10. European Researchers Night 2012, "thermal images in muscular activity evaluation", U. Porto, September, 28, 2012 (<http://nei2012.eu/>)

9.4.16 Other research outputs

1. Award: 1st Place on Category Supporting Materials for On-Line Course, in Competition e-Learning in Praxis of the 6th International Conference on Emerging Technologies and Applications, September 2008: "Laboratories of Instrumentation for Measurement", Maria Teresa Restivo, Fernando Gomes de Almeida, Maria de Fátima Chouzal, Joaquim Gabriel Mendes, António Mendes Lopes.
2. Best paper from a young author in the Journal "Building and Environment" in 2008, awarded by Elsevier for the article "The role of the PASSYS test cell in the modeling and integrated simulation of an innovative window", Vítor Leal.
3. Award: 1st Place Innovation Award, in Nutrition Awards, (weblink), Lisbon (Portugal), June 30, 2010: "Novo Lipocalibrador wireless (New Wireless Skinfold Callipar)", Teresa Restivo, Manuel Quintas, Carlos Silva, Teresa Amaral, Tiago Andrade, Fátima Chouzal.
4. Award: Donald Julius Groen Prize for 2010 from the Institution of Mechanical Engineers for the paper "The effect of temperature on the mechanical properties of adhesives for the automotive industry", Proc IMechE J Materials: Design and Applications 224:51-62, 2010, MD Banea, LFM da Silva.
5. SAGE Best Paper Award 2010, "The effect of temperature on the mechanical properties of adhesives for the automotive industry", Proc IMechE J Materials: Design and Applications 224:51-62, 2010, MD Banea, LFM da Silva.
6. Award: 1st Place Fresenius-Kabi Clinic Nutrition, "Virtual Instrumentation for Body Composition Evaluation", 2009, MT Restivo, TF Amaral, J Mendes, R Guerra, E Marques, MF Chouzal, C Sousa, M Quintas, J Mota.
7. Award for Best Research Project, Solvay & Hovione Innovation Challenge, 2011: Joaquim Gabriel Mendes.
8. Award: Honorable Mention on the "Premio Científico IBM" (IBM scientific award) with a work entitled "Biomechanical study on the damages suffered by the pelvic floor during a vaginal delivery", 2009, MPL Parente.
9. Prize for Scientific Excellence 2011, FEUP, 2012, LFM da Silva.
10. Silver Medal, Salon International des Inventions Genève: M Quintas, C Silva, T Andrade, MT Restivo, MF Chouzal, TF Amaral, 20th of April, Geneva, Switzerland, 2012.

9.4.17 Organisation of scientific dissemination activities

1. EO Fernandes, M Jantunen, P Carrer, O Seppänen, International Workshop "Impact of 'indoor air quality' on health" in the frame of the European Project EnVIE, Brussels, 5-6 March 2008.
2. RM Natal Jorge, S Santos, JMRS Tavares, MAP Vaz, Reis Campos, Organizing committee of the "Internacional Conference on Biodental Engineering", Porto, Portugal, June 2009.
3. AA Fernandes, RM Natal Jorge, Lia Patricio, A Teixeira, A Medeiros, Organizing committee of the "International Conference on Integration of Design, Engineering and Management for innovation, iDEMi 09", Porto, Portugal, September 2009.
4. JMRS Tavares, RM Natal Jorge, Organizing committee of the "VIPIMAGE - Thematic Conference on Computational Vision and Medical Image Processing, Porto, Portugal, October 2009.
5. RP Barneva, VE Brimkov, JMRS Tavares, RM Natal Jorge, Organizing committee of the "CompIMAGE - Computational Modelling of Objects Represented in Images: Fundamentals, Methods and Applications", Buffalo, NY, USA, May 2010.
6. RM Natal Jorge, JMRS Tavares, M Pinotti, A Salde, Organizing committee of the "TMSi - 6th International Conference on Technology and Medical Sciences", Porto, Portugal, October 2010.
7. RM Natal Jorge, JMRS Tavares, AJM Ferreira, JL Alexandre, MAP Vaz, Organizing committee of the "CIBEM10 - X Congresso Ibero-Americano em Engenharia Mecânica", Porto, Portugal, September 2011.
8. JMRS Tavares, RM Natal Jorge, Organizing committee of the "VIPIMAGE - Thematic Conference on Computational Vision and Medical Image Processing", Olhão, Portugal, October 2011.
9. P Giamberardino, D Iacoviello, JMRS Tavares, RM Natal Jorge, Organizing committee of the "CompIMAGE - Computational Modelling of Objects Represented in Images: Fundamentals, Methods and Applications", Sapienza University of Rome, Rome, Italy, September 2012.
10. RM Natal Jorge, JMRS Tavares, MAP Vaz, Reis Campos, S Santos, Organizing committee of the "Internacional Conference on Biodental Engineering", Porto, Portugal, December 2012.

9.4.18 Research contracts with national or international entities

1. Potenciação científica e tecnológica do IDMEC - Pólo FEUP (SAIECT - IEC/2/2010), Funding Agency: QREN, Grant: 851 810 €, Project Coordinators: AA Fernandes, RM Natal Jorge, EO Fernandes, Starting date: January 2011, Conclusion : June 2014.
2. CIBEM10 - X Mechanical Engineering Ibero-American Conference (QREN- PCI-I/2/2010), Funding Agency: QREN, Grant: 100 000 €, Project Coordinator: RM Natal Jorge, Starting date: January 2011, Conclusion: July 2013.
3. RAILWAYS - Rolling contact fatigue (FCT project PTDC/EME-PME/100204/2008), Funding Agency: FCT, Grant: 70 000 €, IDMEC Coordinator: PMST de Castro, Starting date: 2010, Conclusion: 2013.
4. LighTRAIN - Design and development of a platform for innovative aluminum passenger coaches, Financial Institution: QREN, Grant: 100 000 €, IDMEC Coordinator: PMST de Castro, Starting date: December 2011, Completion date: November 2014.
5. HCV - Commercial Vehicle Hybrid (Grant agreement No.: 234019), Funding Agency: European Commission (FP7), Funding: 250 000 €, IDMEC Project Coordinator (Portugal): AA Fernandes, Starting date: January 2010, Completion date: December 2013.
6. Development of Smart Automotive Interiors (MIT-Pt/EDAM-SI/0025/2008), Financial Institution: FCT, Project Coordinator (FEUP): FM Andrade Pires, Funding: 240 000 €, Start Date: July 2009, Completion date: December 2012.
7. EPHECT - Emissions, exposure patterns and health effects of consumer products in the EU (Contract Sanco 2009 12 06), Funding Agency: European Commission, Grant (Portugal): 59.457 €, Starting date: June 2010, Conclusion: September 2013.
8. Experiment@Portugal, Funding: Fundação Calouste Gulbenkian, Funding: 120 000 €, IDMEC Project Coordinator: MT Restivo, Starting date: January 2010, Completion date: December 2011.
9. EnVIE - Co-ordination Action on Indoor Air Quality and Health Effects (Project no. SSPE-CT-2004-502671), 6th FP European Commission, Grant (Portugal): 207.125 €, Starting date: 1 April 2004, Conclusion: 31 October 2008.
10. Sinfonie- Schools Indoor Pollution and Health: Observatory Network in Europe (Contract DG Sanco 2009/C4/04), Funding Agency: European Commission, Grant (Portugal): 373.850 €, Starting date: October 2010, Conclusion: November 2012.

9.4.19 Projects funded in national and international competitive calls

1. Study of hydroformed sandwich shells with metallic foam cores (PTDC/EME-TME/098050/2008), Funding Agency: FCT, Grant: 105 000 €, Project Coordinator: RM Natal Jorge, Starting date: Jan 2010, Conclusion: December 2012.
2. VECOM - Vehicle Concept Modeling (Grant agreement No.: 213543), Program Marie Curie Initial Training Networks (FP7-PEOPLE-2007-1-1-ITN), Funding Agency: European Commission, Grant (Portugal): 190 000 €, IDMEC Project Coordinator (Portugal): RM Natal Jorge, AA Fernandes, Consortium Leader: UPVLC Valencia, Spain, Starting date: October 2010, Conclusion: September 2012.

3. Bio-computational study of tinnitus (PTDC/SAU-BEB/104992/2008), Funding Agency: FCT, Grant : 90 000 €, Project Coordinator: Fernanda Gentil, Starting date: January 2010, Conclusion: December 2012.
4. Adhesively Bonded Functionally graded joint (PTDC/EME-PME/098571/2008), Financial Institution: FCT, Funding: 105 000 €, Project Coordinator: Lucas FM da Silva, Start Date: March 2010, Completion date: February 2013.
5. Improved toughness of adhesives filled with cork micro particles (PTDC/EME-TME/098752/2008), Financial Institution: FCT, Funding: € 100 000, Project Coordinator: Lucas FM da Silva, Start Date: March 2010, Completion date: February 2013.
6. ENLIGHT-Enhanced Lightweight Design, Financial Institution: European Commission (FP7), Funding (Portugal): 272 410 €, Project Coordinators (Portugal): AA Fernandes, RM Natal Jorge, Lucas da Silva, Starting date: October 2012, Completion date: October 2016.
7. ULCF- Ultra Low Cycle Fatigue of Steel Under Cyclic High-Strain Loading Conditions (Contract RFSR-CT-2011-00029), Funding Agency: Research Fund for Coal and Steel/European Commission, Grant (Portugal): 244 531 €, Consortium Coordinator: AA Fernandes, Starting date: July 2011, Conclusion: June 2014.
8. HealthVent - Health based ventilation guidelines for Europe (Contract EAHC 2008 12 08), Funding Agency: European Commission, Grant (Portugal): 68053,90 €, Starting date: June 2010, Conclusion: November 2012.
9. BIOPELVIC - Study of Female Pelvic Floor Disorders (Grant agreement No.: PTDC/SAU-BEB/71459/2006), Funding Agency: FCT, Funding: 191 597 €, IDMEC Project Coordinator: RM Natal Jorge, Starting date: July 2007, Completion date: June 2010.
10. Officair- On the reduction of health effects from combined exposure to indoor air pollutants in modern offices (Contract DG Research 2009602), Funding Agency: European Commission, Grant (Portugal): 249.792 €, Starting date: November 2010, Conclusion: January 2014.

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

Group's Organizational Structure and Management

The group is organized in 4 subgroups:

- Advanced Studies on Energy in the Built Environment
- Design and Experimental Validation
- Numerical Methods in Mechanical and Structural Engineering
- System Integration and Process Automation

Each subgroup has a Subgroup Coordinator (SC), chosen by the Integrated Members of the subgroup.

The group has a Scientific Board, composed by the Group coordinator and Subgroup Coordinators. The Scientific Board will be chaired by the Group Coordinator. The Scientific Board will be responsible for all strategic decisions at group level and through the Coordinator will liaise with the Board and Scientific Council of LAETA. The Scientific Board meetings will be called by the Group Coordinator and will take place once a year; additional meetings can take place whenever required. Decisions will be taken by consensus or, in its absence, by majority vote. The subgroup coordinators will be responsible for reporting yearly the research activities of the subgroup to the Group Coordinator and Scientific Board.

The Group Coordinator will be responsible for the scientific coordination of the group and daily management activities (administrative, financial, etc.) and will represent the group in all management boards and Scientific Council of LAETA (composed by the members of Executive Council, the coordinators of Research Groups, the Coordinators of Research Lines, and three experts from industry) and also externally. If necessary, the Group Coordinator can appoint and be assisted by an Executive Coordinator, a senior researcher from the group. The duties of the Group Coordinator will include, among others: preparation of the annual scientific report of the group, development of initiatives to stimulate and promote new research lines within the group, promote the internationalization of the group through new partnerships and networks and research contracts both at European and world level. Foster new collaborations both with other LAETA's research groups and other national organisations.

The subgroup Coordinator can appoint and be assisted by an Executive Coordinator, a senior integrated member researcher from the subgroup.

Intellectual Property

Intellectual property issues will be dealt with according to the Consortium Agreement to be signed by all Host Institutions and Groups forming LAETA. In particular, research publication rights, patents, software, algorithms, new materials, devices, products and processes produced within the activities of the group will be owned by those who produce them.

Contingency Plan

A contingency plan will be devised to deal with risks associated with the activities of Group in general and activities

within a specific project in particular.

Careful consideration will be given to a fair distribution and allocation of the resources available in particular funds provided by FCT and other funding agencies.

9.5.2 Objectives of the Research Group

The group main research objectives are focused in three main areas: Structural Integrity and Engineering Design, Automation and Control Systems, Energy and Indoor Air Quality.

The subgroup "Engineering Design" covers different themes which are complementary to the activities carried out in other LAETA research groups, namely:

- Computational biomechanics, image processing and soft tissue mechanics of the human body subsystems including studies related with female pelvic floor cavity and organs, biomechanics of human middle ear and analysis of the cardiovascular system.
- Structural integrity of components and structures, namely topics related fracture and fatigue (high cycle, low and ultra low cycle fatigue and rolling contact fatigue).
- Manufacturing processes: hydroforming of sandwich materials and adhesive bonding.
- Transport equipment: vehicle concept modelling, maintenance strategies for axle bearings, passenger railway vehicles and seat design, commercial vehicle and buses design, lightweight car design, smart automotive interiors design, car components (ex. cross car beam).
- Computational methods: computational multiscale modelling of metallic/polymeric materials, numerical modelling (FEM, XFEM and Meshless methods).
- Numerical methods for simulation and optimisation in mechanics, structural and biomechanics, aiming the rationalization of the use of materials, the minimization of the manufacturing costs and the rational use of material and human resources and the sustainable energy use and environmental impact minimisation.
- Product innovation processes.

The subgroup of "Advanced Studies of Energy in the Built Environment" aims at advance research in three interconnected sub-areas: The energy performance of the buildings, the indoor environment and related exposure and health, and the sustainability of cities and regions. Specific objectives are:

- To keep advancing the methods for integrated analysis of energy performance of buildings, as energy systems themselves considering the coexistence of energy efficiency and renewable energy technologies.
- To contribute for the updating of comfort concepts indoors more health-based and its impact on typologies.
- To elaborate on indoor air quality management strategies in tune with the EU strategies of source control.
- Undertaking of exposure studies in association with public health R&D structures and other medical specialists addressing special critical indoor environments such as schools and people in general.
- Advancing the methods for assisting the breakdown of the energy use in cities and regions down to the level of useful energy.

The subgroup "Automation and control systems" will have as its main goals:

- The real-time communication project targets the provision of advanced real-time and reliable communication mechanisms, upon wireless communication networks.
- The advanced control methodologies for decentralization motion control systems project will be involved in the developments of motion control on servopneumatic systems, force and impedance control of servopneumatic systems for haptic devices looking to medical applications, artificial neural networks on the dynamic localization and routing of objects and/or low cost robotic mobile platforms.
- The sensors/transducers project will be focusing its work in the health area mainly centered in: transferring technology activity, development of a low cost, wireless, novel handgrip system prototype, intensify the application of infrared thermography on medical thermal image sensing.
- The virtual reality project will continue its focus on Remote & Virtual Labs and in the "Internet of Things" development: of microcontrollers solutions of low cost webservers; of new solutions for low cost haptic technology; of virtual and augmented reality contents for Higher Education Engineering and for Lifelong training.

(RG-50022-1627) Energy, Environment and Comfort

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1627

9.1.2 Name of the Research Group in portuguese

Energia, Ambiente e Conforto

9.1.3 Name of the Research Group in English

Energy, Environment and Comfort

9.1.4 Keyword(s)

energy efficiency and indoor environmental quality

wind engineering and industrial aerodynamics

industrial ecology

sustainable mobility

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Associação para o Desenvolvimento da Aerodinâmica Industrial (ADAI)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator	Nuclear CV
Manuel Carlos Gameiro da Silva	Yes	Yes
José Joaquim da Costa	No	Yes
ADÉLIO MANUEL RODRIGUES GASPAR	No	No
Fausto Miguel Cereja Seixas Freire	No	Yes
Divo Augusto Alegria Quintela	No	No
Celestino Rodrigues Ruivo	No	No
Almerindo Domingues Ferreira	No	No
Antonio Manuel Gameiro Lopes	No	No
Luis Manuel Ventura Serrano	No	No
Nuno Alexandre Gonçalves Martinho	No	No
Gonçalo Jorge Vieira Nunes Brites	No	No
Avelino Virgílio Fernandes Monteiro de Oliveira	No	No
João Carlos Gonçalves	No	No
João Manuel Nogueira Malça de Matos Ferreira	No	No

9.2.2 List of current PhD students

NAME

Admesio Antonio Carreira Mendes Cabrita

Ana Isabel Fernandes Craveiro

Carla Abreu Rodrigues

Carlos Miguel de Campos Pinto Borges

Cátia Vanessa de Matos Augusto

Érica Gerales Castanheira

Ehsan Asadi

Eugénio Miguel de Sousa Rodrigues
Helena Isabel Pereira Monteiro
João Alexandre Dias Carrilho
Joel Bastos Morgado
Luisa Maria Dias Pereira
Marco Alexandre dos Santos Fernandes
Maria Luísa Ingrês Pais Vaz
Mario Luis Oliveira de Sousa Mateus
Nelson Miguel Lopes Soares
Paulo Alexandre de Matos e Henriques de Carvalho
Paulo Filipe de Almeida Ferreira Tavares
Pedro Manuel Ferreira Gonçalves
Raquel Almeida de Azevedo faria
Rita Pinheiro Garcia
Vanessa Maria Martins Tavares
Vitor Manuel Alves da Silva
Mohammadhossein Ghodsirad

9.2.3 List of other researchers of the Research Group

NAME

Ana Robalo Cordeiro Sousa Oliveira
Carlos José de Oliveira Pereira e Jorge Alcobia
Carlos Miguel Baptista Ferreira
Filipa Daniela Francisco de Figueiredo
Gonçalo Nuno Malaguerra Fonseca
João Carlos Gaspar Teixeira
João Lourenço Lopes Queiroz
Joao Paulo Marques Dias Pinto
Jorge Campos da Silva André
José Inocêncio Fernandes Pinto Barbosa
Liliana Maria Penela Guerra
Luis Adriano Alves de Sousa Oliveira
Luis Paulo Coelho Neto
Nilton Janicas de Oliveira
Pedro Augusto Marques
Sara Cristina Carvalho Francisco
Francisco José Craveiro Bispo Pocinho Lamas
Antonio Manuel Mendes Raimundo

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

During 2008 to 2012 the research & development activities of the Energy, Environment and Comfort (EECI) Research Group were organized in four main areas:

- Energy efficiency and indoor environmental quality;

- Industrial ecology
- Sustainable mobility
- Wind engineering and industrial aerodynamics

The research team had 15 PhD members from 2008 to 2010 and 17 Ph D members in 2011 and 2012. During the period under evaluation the EEC Group had on average 20,6 Ph D students, with a rising evolution between 17 in 2008 and 24 in 2012.

The PhD members are affiliated with the Department of Mechanical Engineering of the University of Coimbra, and the Polytechnics of Coimbra, Leiria and Castelo Branco. The majority of these members are lectures dedicating only half of their time to research.

On average, 10 other grants were attributed per year within EEC group to other post-graduate students collaborating in research projects or specialized services contracts. The technical and administrative staff was composed on average by 7 persons.

The research and development activities of EEC Group (have been funded by the National Science Foundation (FCT), by other public bodies, by the European Union and by private companies in a total of about 2000k€ (1871k€ net), corresponding to an average of 25k€ per PhD (16) per year. The funding distribution for this period was: LAETA funding 10%, the FCT projects 20%, other National funding 5%, contracts and specialized services with national industry 65%.

The overall research & development achievements of the team of the EEC Group in this proposal, during the period of 2008 to 2012, can be summarized as follows:

Books (7), Chapters in books (12), Publications in international Journals with peer review (75), Publications in national Journals (4), Publications in international conferences (147), Publications in national conferences (45), PhD thesis completed (3),

MSc thesis completed (104), International projects (16), National projects (39), Organization of scientific events (35), Patents and prototypes (3), Software applications (21), Technical reports and communications (31).

9.3.2 Main achievements

The main achievements of EEC Research Group are the coexistence of a set of features which assure the possibility of a sustainable growth:

- A highly motivated team with an equilibrated distribution of ages and skills
- A good recognition of the Research Team at national and international level, which assures a good network of contacts. Various integrated members are involved on the Portuguese Association of Engineers direction organs, at regional and national levels. The EEG group is quite involved on the revision of Portuguese regulation regarding the Certification of Buildings. The EEC group coordinator is Vice-President of the Federation of European HVAC Associations (www.rehva.eu)
- A well equipped laboratory with updated experimental facilities that are adapted to the research fields where the group is active (e.g. Wind tunnels, climate chambers, engine test bench,)
- an equilibrated distribution of the budget income sources, since the existence of an accredited laboratory allows a good baseline based upon specialized services provided to industry and other institutions
- the participation in the leadership of the EfS Initiative of the University of Coimbra (www.uc.pt/efs). The EfS Initiative is an interdisciplinary project of the University of Coimbra, focused on different fields (education, R&D, training) which creates the conditions to attract each year a good number of M Sc and Ph D students, originary from countries all over the world
- A good rise in the number of Scientific Productive Indicators, which allowed us to reach a score of 2 international papers per year per integrated member in 2012. Now, that the M SC programme on Energy for Sustainability and the PhD Programme on Sustainable Energy Systems may be considered in steady state regime with a certain number of thesis concluded each year and a reasonable number of running R&D projects, it is expected that the Level of SCIs will keep a rising tendency.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

Ehsan Asadi, Manuel Gameiro da Silva, Carlos Henggeler Antunes, Luís Dias (2012) "Multi-Objective Optimization Retrofit strategies: A model and an application" *Energy and Buildings* Vol. 44, 2012, pp 81-87, <http://dx.doi.org/10.1016/j.enbuild.2011.10.016>, (IF: 2.679, IF5: 3.254, TC: 29)

PM Gonçalves; AR Gaspar, M Gameiro da Silva (2012 - Energy and exergy-based indicators for the energy performance assessment of a hotel building. *Energy and Buildings*, Vol.52, 09/2012, pp 181-188, <http://dx.doi.org/10.1016/j.enbuild.2012.06.011>, (IF:2.679,IF5:3.254, TC:4)

C.R.Ruivo, J.J.Costa, A.R.Figueiredo(2008), On the validity of lumped capacitance approaches for the numerical prediction of heat and mass transfer in desiccant airflow systems, *Int. Journal of Thermal Sciences*, Vol.47, N°3, pp.282-292, <http://dx.doi.org/10.1016/j.ijthermalsci.2007.01.032>, (IF:2.470;IF5:2.74;TC:13)

Oliveira, A. V. M.; Gaspar, A. R. and Quintela, D. A. (2008) Occupational exposure to cold thermal environments: a field study in Portugal. *European Journal of Applied Physiology*, Springer, Vol. 104, N°2, pp. 207-214. <http://dx.doi.org/10.1007/s00421-007-0630-5>. (FI:1.752; TC:6)

Malça, J., Freire, F. (2011). "Life-cycle studies of biodiesel in Europe: A review addressing the variability of results and modeling issues". *Renewable and Sustainable Energy Reviews*, Vol. 15, nº1, 338-351, <http://dx.doi.org/10.1016/j.rser.2010.09.013>, (IF:5.627, IF5:6.577, TC:40)

Gaspar, A.R., Quintela, D.A.(2009) " Physical modelling of globe and natural wet bulb temperatures to predict WBGT heat stress index in outdoor environments", *International Journal of Biometeorology*, volume 53, issue 3, year 2009, pp. 221 - 230, <http://dx.doi.org/10.1007/s00484-009-0207-6>, (IF:2.590; TC:11)

A.D. Ferreira and R.G.A. Oliveira (2009), "Wind erosion of sand placed inside a rectangular box", *Journal of Wind Engineering and Industrial Aerodynamics*, 2009, Vol. 97, pp. 1-10, <http://dx.doi.org/10.1016/j.jweia.2008.09.001>, (IF:1.342; IF5:1.882; TC:6)

N. Martinho, A. Lopes. M, and M. Gameiro da Silva (2012) Evaluation of errors on the CFD computation of air flow and heat transfer around the human body. *Building and Environment*, <http://dx.doi.org/10.1016/j.buildenv.2012.06.018>, (IF: 2.430, IF5: 2.699, TC: 1)

L Serrano; R Câmara; V Carreira; M Gameiro da Silva(2012)- Performance study about biodiesel impact on buses engines using dynamometer tests and fleet consumption data, *Energy Conversion and Management*, Vol.60, 08/2012, pp 2-9, <http://dx.doi.org/10.1016/j.enconman.2011.11.029>, (IF:2.775,IF5:3.075,TC9)

Malça, J., Freire, F. (2010). "Uncertainty Analysis in Biofuel Systems: An Application to the Life Cycle of Rapeseed Oil". *Journal of Industrial Ecology*, Vol. 14, nº2, 322-334, <http://dx.doi.org/10.1111/j.1530-9290.2010.00227.x>, (IF:2.276, TC: 19)

9.4.2 Completed PhD theses

1. Nuno Alexandre Gonçalves Martinho, *Modelo Termofisiológico Computacional Completo para Avaliação do Conforto Térmico Humano*, Universidade de Coimbra, 2012.

2. João Carlos Gonçalves (2011). "Estudo numérico e experimental da vedação aerodinâmica em espaços refrigerados". *Doutoramento em Engenharia Mecânica*, Universidade de Coimbra. Supervisor: José Joaquim da Costa; co-orientador: António Rui Figueiredo.

3. João Manuel Nogueira Malça de Matos Ferreira (2011), "Incorporating uncertainty in the life-cycle modeling of biofuels: energy renewability and GHG intensity of biodiesel and bioethanol in Europe", Ph D thesis in Mechanical Engineering, Faculty of Science and Technology of the University of Coimbra, Supervisor: Prof. Fausto Freire, November 2011.

9.4.3 Patents and Prototypes or other research outputs

1. Figueiredo N., Costa V. A. F., Lopes A. M. G., Vieira H. & Padilha F. J. T.: Dosing Device of a Service Liquid for Flushing Tank, and Flushing Tank Provided with such a Dosing Device, *Pedido de Patente Europeia*, submetido em 09 de Novembro de 2012, com a referência IT/10.11.11/ITA TO20111038.

2. Lopes, A.M.G, Costa, V.A., Gonçalves da Costa, A., "Silencer for a water dispensing, in particular for a flush tank fill valve or a similar device", Date of Filing: 03-04-2009; Priority: IT/04.04.08/ITA MI20080593

9.4.4 Books and book chapters of international circulation

Guidebook nº 14 *Indoor Climate Quality Assessment*, editors Stefano Paolo Cognatti and Manuel Gameiro da Silva, REHVA, Brussels, May 2011.

Malça J, Freire F (2012). Ethanol from sugar beet. In: *Encyclopedia of Energy*, Morris A. Pierce ed., Pasadena: Salem Press (in press). ISBN: 978-1-58765-849-5.

Malça J, Freire F (2012). Vegetable oil fuel. In: *Encyclopedia of Energy*, Morris A. Pierce ed., Pasadena: Salem Press (in press). ISBN: 978-1-58765-849-5.

Malça J, Oliveira T (2012). Air-Conditioning. In: *Encyclopedia of Energy*, Morris A. Pierce ed., Pasadena: Salem Press (in press). ISBN: 978-1-58765-849-5.

C. R. Ruivo, J. J. Costa and A. R. Figueiredo (2011), "Heat and mass transfer in matrices of hygroscopic wheels", in Delgado, J.M.P.Q. (ed.), *Heat and Mass Transfer in Porous Media*, *Advanced Structured Materials* 13, DOI: 10.1007/978-3-642-21966-5_10, Springer-Verlag Berlin Heidelberg 2011, ISBN : 978-3-642-21965-8.

Celestino Ruivo, José Costa, António Rui Figueiredo (2011), "Heat and Mass Transfer in Desiccant Wheels", *Advanced Topics in Mass Transfer*, Mohamed El-Amin (Ed.), ISBN: 978-953-307-333-0, InTechWeb, Available from: <http://www.intechopen.com/articles/show/title/heat-and-mass-transfer-in-desiccant-wheels>.

Luis Serrano, José Costa and Manuel Gameiro da Silva (2011), "Impact of Advances on Computing and Communication Systems in Automotive Testing" paper 44 of *Handbook of Research on Mobility and Computing: Evolving Technologies and Ubiquitous Impacts*, (pages 703-718), ed. Maria Manuela Cruz-Cunha and Fernando Moreira, IGI Global, Hershey USA, April 2011, DOI: 10.4018/978-1-60960-042-6.

M. Gameiro da Silva, Ehsan Asadi, José Costa (2011), "Case Study 3 - Assessment of indoor climate and energy consumption in an office building by wireless network web-based monitoring solution", *REHVA Guidebook nº 14*, PP.

84-88; S. P. Corgnati and M. Gameiro da Silva (editors).

Malça, J.; Freire F. (2011). "Uncertainty Analysis of the Life-cycle Greenhouse Gas Emissions and Energy Renewability of Biofuels". In: Environmental Impact of Biofuels, Marco Aurélio dos Santos Bernardes ed., chapter 10, 26 pp., InTech Publishers, Vienna. ISBN: 978-953-307-178-7.

Gameiro da Silva, M. (2010) - contribution about Indoor Air Quality, included in the Portuguese translation of Rehva Guidebook nº 13, Part I Principles, ed. Francesca E. de Ambrosio Alfano.. Also included in the Portuguese translation of the guidebook, published by Ordem dos Engenheiros, Lisbon, October 2010

9.4.5 Conference proceedings

Mateus M, Gameiro da Silva MC, Estudo sobre o factor de correcção acústica nas medições de ruído ambiental com microfone aplicado directamente em elementos de fachada, Actas de Acústica 2012 - VIII Congresso Ibero-Americano de Acústica, 1-3 Outubro de 2012, Évora Portugal, ISBN 978-989-20-3284-9

Brites, G.; Hauer, R.; Costa J. J. and Gaspar, A.R. (2011). "Ventilation and heating strategies for a passive house in Mediterranean climates". ROOMVENT 2011 - 12th International Conference on Air Distribution in Rooms, Trondheim - Norway, 19-22 June 2011.

Cátia Augusto, José Ribeiro, Adélio Gaspar, J. J. Costa (2011), "Development and calibration of a mathematical model for vacuum evaporative cooling", Poster and oral presentation, Proc. ICR 2011 - the 23rd IIR International Congress of Refrigeration, Prague, Czech Republic, August 21-26, 2011.

Gameiro da Silva, M.; Costa J. J.; Gaspar, A.R.; Paulino, A.; Bento, Miguel and Botte, G. (2011). "The influence of wind on the infiltration rates in a web-based monitored office building". ROOMVENT 2011 - 12th International Conference on Air Distribution in Rooms, Trondheim - Norway, 19-22 June 2011.

Safaei, A., Freire, F., and Antunes, C. H. (2011). "A Mixed Integer Linear Programming Model to Minimize the Life-Cycle Costs of Meeting Energy Demand in Service Sector Buildings". ICEET 2011 - International Conference on Environmental Engineering and Technology, July 13-15, Amsterdam, Netherlands.

Asadi, E. J. J. Costa and M. Gameiro da Silva (2010), "Measurement and simulation of indoor air quality and CO2 concentration in a hotel room", ESDA2010 - ASME 2010 10th Biennial Conference on Engineering Systems Design and Analysis, Istanbul, Turkey, July 12-14, 2010 (Paper nº ESDA2010-25143).

Malça, J.; Freire F. (2011). "Capturing Uncertainty in GHG Savings and Carbon Payback Time of Rapeseed Oil displacing Fossil Diesel in Europe". 2011 IEEE International Symposium on Sustainable Systems and Technology. Chicago, Illinois.

Farimani, A.B., Ferreira, A.D., Sousa, A.C.M. (2010), "Numerical simulation of wind erosion of a sinusoidal using a moving boundary technique", Proc. ECCOMAS- Fifth European Conference on Computational Fluid Dynamics, Eds. J. C. F. Pereira, A. Sequeira, Lisboa - Portugal, 14 a 17 de Junho de 2010, 14 pages.

P. Gonçalves, A. Gaspar, M. Gameiro da Silva (2011), "Comparative Exergy and Energy Performance Analysis of a Separated and Combined Heat and Power System for a Student Housing Building", 2nd International Conference in Microgeneration and Related Technologies in Buildings: Microgen `II, Univ of Strathclyde, Glasgow, 4-6 April 2011.

P. Santos, L. Simões da Silva, H. Gervásio and A. Gameiro Lopes (2011), CLIMATE CHANGE IMPACT ON THE ENERGY EFFICIENCY OF LIGHT-WEIGHT STEEL RESIDENTIAL BUILDINGS, SB11 World Sustainable Building Conference, 18-21 October 2011, Helsinki.

9.4.6 New materials, devices, products and processes

9.4.7 Software, computer code and algorithms

M. Gameiro da Silva, (2009), "Teaching Software Tools for the assessment of Indoor Environment Quality". Reported in M. G. Silva (2009), " Virtual Laboratories for a Course on Indoor Environmental Quality", iJOE - Volume 5, Special Issue 2: "IRF'09", November 2009 (doi:10.3991/ijoe.v5s2.1107).

WindStation - Software para cálculo do campo de ventos em topografia complexa. Desenvolvido na plataforma gráfica VisualBasic. Registado na Inspecção Geral das Actividades Culturais sob o número 1844/2010. Informação e disponibilidade da versão de demonstração em: <http://www.easycfd.net/windstation>.

CalproTerm, folha de cálculo Excel para determinação das propriedades termofísicas dos elementos de construção dos edifícios, 2009.

Ventila-Rsece, folha de cálculo Excel para cálculo dos caudais de ventilação de acordo com o RSECE (Regulamento dos Sistemas Energéticos de Climatização em Edifícios), 2010.

ClasseSCE-Rsece, folha de cálculo Excel para verificação regulamentar dos consumos energéticos de edifícios novos e existentes com o RSECE (Regulamento dos Sistemas Energéticos de Climatização em Edifícios), 2010.

VercTerm, folha de cálculo Excel para verificação o RCCTE (Regulamento das Características de Comportamento Térmico dos Edifícios), 2011.

CalcTerm, programa (em Visual Basic) de simulação do comportamento térmico e energético de edifícios, 2011.

Huthereg, programa de simulação do comportamento termofisiológico do corpo humano, 2008.

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

Dissertação e Tese em Ciência e Tecnologia" (2ª. ed.), L. A. Oliveira - LIDEL, ISBN-978-972-757-742-2, 2012.

Oliveira, L.A., "Dissertação e Tese em Ciência e Tecnologia". LIDEL, ISBN-978-972-757-742-2, 2011.

Lopes, A.M.G., "Introdução à Programação em Visual Basic 2010 (2ª. ed.)", FCA - Editora de Informática, Lda., ISBN-978-972-722-644-3; 448 páginas, 2011.

Lopes, A.M.G., "Introdução à Programação em Visual Basic 2010", FCA - Editora de Informática, Lda., ISBN-978-972-722-644-3; 448 páginas, 2010.

Oliveira, L.A., Lopes, A.M.G., "Mecânica dos Fluidos (3ª. ed.)", ETEP - Edições Técnicas e Profissionais, ISBN-13:978-972-8480-28-8; 792 páginas, 2010.

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

Malça J, Oliveira T (2012). Heat Pumps. In: Encyclopedia of Energy, Morris A. Pierce ed., Pasadena: Salem Press (in press). ISBN: 978-1-58765-849-5.

Roseiro L., Alcobia C., Ferreira P., Baïri D., Laraqi N. and Alilat N., Chapter 44 - Identification of the Forces in the Suspension System of a Race Car Using Artificial Neural Networks, in Computational Intelligence and Decision Making - Trends and Applications Volume 61, Springer Book, 469-478, 2012. (ISBN: 978-9400747210).

M. Gameiro da Silva, Ehsan Asadi, José J. Costa (2011), "Case Study 2 - Assessment of indoor thermal and air quality in a bank agency by short term measurements", in "Indoor Climate Quality Assessment", REHVA Guidebook nº 14, PP. 84-88; S. P. Corgnati and M. Gameiro da Silva (editors).

M. Gameiro da Silva, Stefano Corgnati (2011), "Chapter 4 - Theoretical Background on ICQ", REHVA Guidebook nº 14, PP. 84-88; S. P. Corgnati and M. Gameiro da Silva (editors).

Malça J, Freire F (2011). "Ethanol from sugar beet". Encyclopedia of Energy, New York: Salem Press.

Malça J, Freire F (2011). "Ethanol from wheat". Encyclopedia of Energy, New York: Salem Press.

Malça J, Freire F (2011). "Vegetable oil fuel". Encyclopedia of Energy, New York: Salem Press.

Castanheira É.G. (2010). "Processos e Tecnologias de Tratamento. Capítulo V", in Kikuchi R., Gerardo R. (eds) Gestão dos Resíduos Sólidos no Mundo e em África. CERNAS - Centro de Estudos de Recursos Naturais, Ambiente e Sociedade 2010.

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

9.4.17 Organisation of scientific dissemination activities

7I3M - Seventh International Meeting on Thermal Manikins and Modelling, FCTUC, University of Coimbra, Portugal, September 2008, Chairman: Manuel Gameiro da Silva

Malça, J, II LAETA Young Researchers Meeting 2012, April 10-11, FEUP, Porto, Portugal.

Prof Manuel Gameiro da Silva and Prof Fausto Freire were members of the organizing committee of the National Meeting of the Mechanical Engineering Colledge of the Portuguese Association of Engineers, which took place in February 2009

12 editions of training courses for Qualified Experts of the Portuguese Certification of Buildings System

9.4.18 Research contracts with national or international entities

3ES- Escolas Energeticamente Eficientes, granted by the company Teixeira Duarte in the framework of the R&D projects associated to large public tenders, Partnership:TDGI / ADAI / INESC Coimbra / GEMF-FEUC. 2012-2013. EEC Group Budget :189 k€, Total Budget: 700 k€

GALP-FUELS Research contract with Petrogal with the objective of developping methodologies for the evaluation of the performance of fuels. Partnership: Petrogal / ADAI 2012-2014: Budget: 70 k€

- QREN/5433; PrisonAir: An innovative ventilation system for toilet compartments; 370/68; ADI; 2009-2010; António Gameiro Lopes

9.4.19 Projects funded in national and international competitive calls

SB - Sustainable Buildings, Projecto QREN 11508; 2009-2012; Partnership ADAI-FCTUC and WSBP, Lda

Research Project TRANSURB, granted by FCT, ref. PTDC/TRA/73637/2006 Influence of the transit on the quality of urban environment, Partnership ADAI-FCTUC, IPL and ISEC, from November 2007 to November 2010

Projeto InovEnergy - Energy efficiency in the Agro-industrial sector. Projecto n.º 18642, Funded by COMPETE - SIAC. Since 01 - September 2011, duration of 2 years. Total ADAI budget of 155k€.

MIT/SET/0014/2009. Capturing Uncertainty in Biofuels for Transportation. Resolving Environmental Performance and Enabling Improved Use; Total Budget/Adai-EEC Budget 198.758 €/146.688 €; FCT. 2010- 2013

EcoDeep - Eco-efficiency and Eco-management in Agro-industry. Funded by COMPETE - Programa Operacional Factores de Competitividade, pelo QREN - Quadro de Referência Estratégico Nacional e pela União Europeia - Fundo Europeu de Desenvolvimento Regional.

PTDC/EME-MFE/73453/2006; Nemodhe; Numerical and experimental modeling of detailed human body heat exchanges; 75/75; FCT; 2007-2010; Adélio Gaspar

MIT/SET/0014/2009. Economic and Environmental Sustainability of Electric Vehicle Systems; 198.78/66.18; FCT. 2010- 2013. Luis Dias/Fausto Freire

PTDC/TRA/72996/2006) BIOFUEL - Biofuel systems for transportation in Portugal: A "well-to-wheels" integrated multi-objective assessment; 145/145 ;FCT 2007-2010

PTDC/EQU-ERQ/72493/2006 - New Bioethers from Glycerol; 164/??? ;FCT 2007-2010

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The Research Group coordination is assured by Prof Manuel Gameiro da Silva, Coordinator, and Prof José Joaquim Costa, Vice-Coordinator.

The leadership of the Research Sub-Areas is done by Prof Adelio Gaspar (Nearly Zero energy Buildings), Prof Almerindo Ferreira (Wind Engineering and Industrial Aerodynamics), Prof António Gameiro Lopes (Sustainable Mobility) and Prof Fausto Freire (Industrial Ecology)

9.5.2 Objectives of the Research Group

Contribute to develop or improve analytical, computational or experimental methods in the areas defined for the actuation of the research group (energy efficiency, environmental assessment and management, indoor environmental quality, wind engineering, industrial aerodynamics and, industrial ecology).

- Develop fundamental and applied research on strategic areas related to energy efficiency in buildings, transportation and industry, to provide guidelines and define policies both at national and at international levels.
- Contribute to develop methods that warrant an holistic view on the evaluation of energetic and environmental problems in human occupied enclosures (buildings or vehicles), considering the energy consumption by energy vector, the outdoor conditions, the performance of passive and active energetic solutions and the provided indoor environmental quality.
- Develop methodologies to analyze at different scales the human/environment interaction, aiming the minimization of environmental impacts and the search for more sustainable solutions. Establishing the connections between the different scales used to analyze the situations will be an important issue to be considered.

- Contribute to the transfer of knowledge and technology to industry and other relevant stakeholders in the fields of actuation of the Research Group.
- Establish strong relationships with other research groups within LAETA, acting in similar fields, in order to promote the cross fertilization of ideas, the collaborative supervision of training researchers and the establishment of partnerships in national and international research projects.
- Increase the participation in international partnerships and improve the scientific indicators of the research group, mainly in terms of ISI papers and patents.
- Have a strong commitment on the promotion of excellence on teaching and training activities, taking profit from the benefits that this attitude generates on the attraction of more skilled students.

(RG-50022-1628) Forest Fires and Detonics

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1628

9.1.2 Name of the Research Group in portuguese

Fogos Florestais e Detónica

9.1.3 Name of the Research Group in English

Forest Fires and Detonics

9.1.4 Keyword(s)

Forest fires

Fire safety

Building and industrial fires

Combustion and Detonation

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Associação para o Desenvolvimento da Aerodinâmica Industrial (ADAI)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
Domingos Xavier Filomeno Carlos Viegas	Yes	Yes
Eusebio Zeferino Encarnacao Conceicao	No	No
José Leandro Simões de Andrade Campos	No	No
José Carlos Miranda Góis	No	No
Miguel Abrantes de Figueiredo Bernardo de Almeida	No	No
Ricardo Antonio Lopes Mendes	No	No
Jose Manuel Baranda Moreira Da Silva Ribeiro	No	Yes
Antonio Rui de Almeida Figueiredo	No	Yes

9.2.2 List of current PhD students

NAME

Jorge Rafael Nogueira Raposo

Sérgio Miguel Gomes Lopes

Maria Luísa Ingrês Pais Vaz

Vitor Manuel Alves da Silva

Admesio Antonio Carreira Mendes Cabrita

Alexandre José de Sousa da Conceição Pires

Carlos Miguel Baptista Ferreira

António Carlos da Cruz Patrão

9.2.3 List of other researchers of the Research Group

NAME

Luis Mário da Silva Ribeiro

Maria Teresa dos Santos Pais Viegas

Valeria Reva

Ricardo Filipe Silva de Oliveira

Igor Plaksin

Luís João Soares de Sousa Rodrigues

Pedro Jorge Pereira Vieira

Telma Alexandra Jesus Matias

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

The Forest Fires and Detonics Group of LAETA is a research group hosted by ADAI and the Department of Mechanical Engineering of the University of Coimbra that is composed by eight PhD full time researchers that are dedicated to the fields of forest fires and detonics since 1990. These activities are unique in the academic research in Portugal and our Group is recognized internationally as a reference in both fields.

Research activity in forest fires is dedicated mostly to physical aspects of fire propagation, including fuels characterization, meteorology and climate parameters and risk assessment, including interaction with other natural and manmade risks. Our main field of research is on the role of topography and wind on fire spread, on extreme fire behavior and on fire safety. Our team is well known for the advances we made in the modelling of fires that are associated to many fatal accidents namely eruptive fires.

Our team is multidisciplinary and we receive trainees from different background or nationality. This work was carried out in the scope of more than 20 EU projects and 30 national projects and research contracts. One of our main assets is our Forest Fire Research Laboratory that is unique in Europe and possibly in the World for its original rigs dedicated to this field. We have collaboration with research and operational institutions from various parts of the world and participate in the training process of Portuguese operational forces.

In the field of detonics our Group develops activities in various topics, namely:

- i) on fundamental aspects of the detonation process (initiation, propagation and extinction) of military and civil explosives. The research on this specific area is being supported by the development of a set of innovative, spacial (μm) and temporal (ns) resolved, experimental techniques that allows the characterization of all the previous referred phases of detonation at a crystal level;
- ii) on the development and characterization of new energetic material: propellants and explosives. This research activity is, in part, sustained by the knowledge and results generated on the topic i) and involves also concerns with the time-life, the disposal paths and environmental and toxicological impacts of energetic materials or defense artifacts (ammunitions or weapons systems components);
- iii) on the development of explosive based technologies for material processing, specifically, on welding of dissimilar metals, on the compaction/consolidation or shock activation of nano-crystalline metal or super-hard ceramic powders and on the synthesizes of metal oxide particles with tailored properties;
- iv) on security issues and non-lethal weapons related problems, in particular, on methods to detect and destroy safely explosives or suspect volumes that may contain explosives,

v) on safety issues, and particularly on dust explosions (eg. determination of explosion limits) in the manufacturer industry and, specially, on mass explosions in pyrotechnics industry with which a strong relationship is established. One important asset that our team uses is the Detonics Laboratory. This lab was created by our own initiative and with our meanwhile generated resources and is the only academic structure that exists in Portugal dedicated to the study of the physics and chemistry of shock and detonation waves and associated phenomena. The laboratory possess legal authorization and unique conditions to work with explosives, that means, several, different size, detonation chambers and a state of the art characterization/diagnostic equipment to test up to 1 kg of TNT equivalent explosive with safety. All, the research activity on this field is being supported by several projects including 20 national (some of them with the industry), 6 European and 5 bilateral (with the USA).

9.3.2 Main achievements

FOREST FIRES (FF)

Meteorology and Fuels - Analysis of fuel moisture (FM) response to meteorological parameters and development of FM prediction models for Portuguese fuels. Maintenance of a database on field measurements of FM initiated in 1986.

Definition of characteristic parameters of fuel models and a methodology to create a fuel map of Europe. Development of fuel maps for Portugal within a project. Development of semi-automatic fuel maps for Europe within an EU project.

Fire Behaviour - Extension of Fire Research Laboratory with unique fire test benches; development of a model to predict fire line rotation; analysis of combustibility of potential embers, spot fires generation and transport modelling. A PhD thesis was completed on this study; ignition of fuel beds by burning particles. Completion of a Master thesis with preliminary results on the probability of ignition of fuel brands. Analysis of "Jump Fires" triggered by the merging of two linear fires making a small angle between them. Analysis of Canberra 2003 fires by request of New South Wales Government, in the context of a court litigation, in 2010. Report on the analysis of the large fire of Tavira and São Brás de Alportel requested by the Portuguese Government in 2012.

Urban Wildland Interface fires - A project entitled FIRECAMP, involving four units of LAETA is being developed on fire risk in camping.

Fire Safety - Analysis of the Mount Carmel accident in Israel in Dec. 2010, with 43 victims. Report on the fire by request of Israel Authorities. Investigation of accidents of Armamar (1985) and of Águeda (1986). Membership of national accident investigation team in Spain by invitation from Spanish Government.

Decision Support Systems - Test and application of new sensors and communication technologies and knowledge to support decisions in FF management.

Training - training of post graduate and graduate students in the field of forest fires. Organization of a specialized Course on Forest Fires in Coimbra for BEST students in July 2010. Organization of two International specialized Courses on Forest Fire behaviour and on Fire Safety. Collaboration on the training of fire officers, under an agreement with the National Fire Brigade School. Collaboration in training in other Countries, namely in Spain, Italy, Croatia and Korea.

DETONICS

Diagnostics - Creation of facilities and development of skills to perform innovative time and space resolved experimental tests of shock and thermal driven phenomena in reactive and inert material; Implementation of a piezoresistive gauge based experimental technique for the characterization, with a nanosecond resolution, of the pressure-time histories associated to shock and detonation processes in condensed material.

Detonation phenomena - Development of realistic physical models for initiation, shock to detonation transition and self-sustained detonation wave propagation in energetic materials.

The role of the radiation impact on the initiation process of high explosives was presented and proved. The behaviour of fine aluminium powder on the detonation process of non-ideal explosives was presented. Development of a methodology/software tool for the calibration of hydrocodes used in numerical simulation of detonation phenomena and shock wave propagation in condensed material

Explosive-based technologies - Development of patented detonation assisted production technology for fine and ultra-fine metal oxide nano-crystalline powders. Execution of extensive experimental programs on explosive compaction of nano-structured materials (stainless steel, copper, W-C and B4C) and explosive welding of stainless steel-carbon steel and aluminium Copper in cylindrical and plane configuration.

Environmental effects of ammunitions - Use of the Life Cycle Analysis methodology for the evaluation of the environmental impact associated with the demilitarization process as it is done in Portugal by the IDD.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

V.A.F. Costa, M.L. Mendonça, A.R. Figueiredo, "Modelling and simulation of wetted porous thermal barriers operating under high temperature or high heat flux", International J. Heat and Mass Transfer, 51 (2008) 3342-3354.

WOS:000257614800009

A. Raimundo, A.R. Figueiredo, "Personal protective clothing and safety of fire-fighters near a high intensity fire front", Fire Safety Journal, 44(2009) 514-521. WOS:000265736200009

A.R. Farinha, J.B. Ribeiro, R. Mendes and M.T. Vieira, Shock activation of α -alumina from calcinated Al-rich sludge, Ceramics International 35 (2009) 1897-1904. WOS:000266524700025

A. R. Farinha, R. Mendes, J. Ribeiro, R. Calinas and M. T. Vieira, Behavior of explosive densification of nanometric

copper powders, *J. Alloys Compounds* 483 (2009) 235-238. WOS:000270619600058

Viegas, DX; Almeida, M; Miranda, AI; Ribeiro, LM, Linear model for spread rate and mass loss rate for mixed-size fuel beds, *INTERNATIONAL JOURNAL OF WILDLAND FIRE*, 2010, Vol. 19: 531-540. WOS:000280708000001

Alves, CA; Goncalves, C; Pio, CA; Mirante, F; Caseiro, A; Tarelho, L; Freitas, MC; Viegas, DX, Smoke emissions from biomass burning in a Mediterranean shrubland, *ATMOSPHERIC ENVIRONMENT*, 2010, Vol. 44: 3024-3033. WOS:000280616100010

Miranda, AI; Martins, V; Cascao, P; Amorim, JH; Valente, J; Tavares, R; Borrego, C; Tchepel, O; Ferreira, AJ; Cordeiro, CR; Viegas, DX; Ribeiro, LM; Pita, LP, Monitoring of firefighters exposure to smoke during fire experiments in Portugal, *ENVIRONMENT INTERNATIONAL*, 2010, Vol. 36: 736-745. WOS:000280886700012

Carvalho, AC; Carvalho, A; Martins, H; Marques, C; Rocha, A; Borrego, C; Viegas, DX; Miranda, AI, Fire weather risk assessment under climate change using a dynamical downscaling approach, *ENVIRONMENTAL MODELLING & SOFTWARE*, 2011, Vol. 26: 1123-1133. WOS:000291523900007

Viegas, D.X., Raposo, J.R., Davim, D., Rossa C.G., 2012. Study of the Jump Fire Produced by the Interaction of Two Oblique Fire Fronts. Part 1: Analytical Model and Validation with No-slope Laboratory Experiments. *International Journal of Wildland Fire* 21, 843-856. Doi:10.1071/WF10155. WOS:000310004400005

R. Mendes, J. Ribeiro, I. Plaksin, and J. Campos, Non Ideal detonation of emulsion explosives mixed with metal particles, *Shock Compression of Condensed Matter CP 1426*, (2012), p. 267-270

9.4.2 Completed PhD theses

Rossa C. G., 2010. Dynamic Model for Forest Fire Behaviour Prediction. Tese de Doutoramento. Departamento de Engenharia Mecânica, 2009. University of Coimbra. Presented in 20 January 2010.

Miguel A. Almeida, 2011. Propagação de Incêndios Florestais por Focos Secundários. University of Coimbra.

9.4.3 Patents and Prototypes or other research outputs

Prototype - Burning Trees Structure (EQA) The burning trees structure is a device that was built specifically to study the burning of trees and shrubs and the generation of burning particles responsible for the spotting phenomena that may occur during forest fires. On this structure it is possible to study the specific properties of particle emission from different forest fuels on this process. This equipment consists on a metal platform with a square shape (1.5 x 1.5 m²). In the centre of the platform there is a metal grapple that is used to fix the trees and shrubs. The platform is supported by 3 load cells, which are connected to a PC. With the load cells it is possible to assess in real-time the mass loss during the combustion process. The particles' counting and the flow field around the burning tree is made with the help of a PIV system.

Prototype - Oblique Combustion Tunnel (OCT) The Oblique Combustion Tunnel (OCT) is also a unique equipment in Europe of original design and allows the test of aerodynamic and combustion characteristics of particles for arbitrary flow angle and particle position.

Prototype - Large Combustion Wind Tunnel designed by DX Viegas and to be built locally. This Combustion Tunnel will be probably the largest in Europe or in the World and will provide condition to analyse fire spread with the influence of wind at a scale that is much larger than what was available until now.

Prototype - Dihedral Table Device - this is an original structure designed to analyse the spread of a fire front on a slope of varying inclination. It allows the laboratory simulation of the fire spread in two adjacent slopes with adjustable slope in the range of $\pm 45^\circ$ independently for each slope. This possibility provides great freedom of creating configurations from simple slopes to valleys or ridges of triangular section. Given its dimensions (two faces each one with 3x4 m²) and its design this is a unique piece of laboratory equipment at international level.

9.4.4 Books and book chapters of international circulation

Plaksin I, R. Mendes and J. Ribeiro (Eds.) 2008, "Book of Abstracts, 7th Biennale International Conference "New Models and Hydrocodes for Shock Wave Processes in Condensed Matter, 18-23 May 2008, Lisbon - Monte Estoril, PORTUGAL", ADAI - University of Coimbra, May 2008.

Fujioka FM., Gill AM, Viegas DX, Wotton BM and Shyh-Chin Chen, 2008. Climatic and weather factors affecting fire occurrence and behavior. In *Wildland Fires and Air Pollution*. Editors: Andrzej Bytnerowicz, Michael Arbaugh, Christian Andersen and Allen Riebau. Elsevier. ISBN-13: 978-0-08-055609-3, 688 pages.

Viegas D.X., Ribeiro L.M., Viegas M.T., Pita L.P., Rossa C., 2009. Impacts of Fire on Society: Extreme Fire Propagation Issues. In E. Chuvieco (Ed.), *Earth Observation of Wildland Fires in Mediterranean Ecosystems* (pp. 97-109), ISBN 978-3-642-01753-7, Springer-Verlag.

Viegas DX, Caballero D, 2009. The Accident of Guadalajara (Spain). In D. X. Viegas (Ed.), *Recent Forest Fire Related Accidents in Europe*. European Commission, JRC, Institute for Environment and Sustainability, pp.10-17.

Viegas DX, Pita L, Rossa C, Ribeiro L, 2009. The Accident of Famalicão (Portugal). In D. X. Viegas (Ed.), *Recent Forest Fire Related Accidents in Europe*. European Commission, JRC, Institute for Environment and Sustainability, pp.

18-25.

Stipanicev D, Viegas DX, 2009. The Accident of Kornati (Croatia). In D. X. Viegas (Ed.), Recent Forest Fire Related Accidents in Europe. European Commission, JRC, Institute for Environment and Sustainability, pp. 26-53.

Xanthopoulos G, Viegas DX, Caballero D, 2009. The Accident of Arthemida (Greece). In D. X. Viegas (Ed.), Recent Forest Fire Related Accidents in Europe. European Commission, JRC, Institute for Environment and Sustainability, pp. 65-75.

Viegas DX (Ed.), Proceedings of the VI International Conference on Forest Fire Research (Nov. 15-18, 2010, Coimbra, Portugal), Viegas, D.X. (ed.), ADAI. Abstract book and CD-ROM. ISBN 978-989-20-2157-7.

A.R. Figueiredo, Assessment of the internal hygrothermal conditions in the General Library of the University of Coimbra, IEE - Indoor Environment Engineering in Cultural Heritage, LAMBERT Academic Publishing, December 2010, Chapter 9, section 9.4.

Viegas, D.X., 2012. Extreme Fire Behaviour. In: Armando C. Bonilla Cruz and Ramona E. Guzman Correa (Ed.), Forest Management: Technology, Practices and Impact. Nova Science Publishers, Inc. ISBN 978-1-62081-359-1. pp: 1-56.

9.4.5 Conference proceedings

C. R. Ruivo, J. J. Costa, A. R. Figueiredo, Numerical modelling of the heat and mass transfer in a channel with hygroscopic walls, 3rd International Conference on Diffusion in Solids and Liquids Location: Algarve, PORTUGAL Date: JUL 04-06, 2007, Diffusion in Solids and Liquids III - Defect and Diffusion Forum, 2008, Vols. 273-276, pp. 782-788. WOS:000254387700126

Viegas DX, L. Pita P, Nielsen F, Haddad K, Calisti Tassini C, D'Altrui G, Quaranta V, Dimino I and Tsangaris H (2008) Acoustic and thermal characterization of a forest fire event. PROCEEDINGS OF THE SOCIETY OF PHOTO-OPTICAL INSTRUMENTATION ENGINEERS (SPIE), San Diego, CA Date: AUG 10, 2008 , Volume: 7089 Article Number: 708904 DOI: 10.1117/12.794601. WOS:000262362300003

J. Campos, L. Duraes, T. Matias, A. Portugal, R. Mendes, I. Plaksin, J. Gois, J.Ribeiro, A. Andrade Campos, Prediction of Reaction Properties of Pyrolysis, Deflagration and Detonation of Energetic Materials, 1st Korean Int. Symposium on High Energy Materials, October, 6-9, Incheon, Korea, 2009.

Almeida, M., D.X. Viegas, A.I. Miranda, V.Reva. Combustibility of Potential Embers. In Anderssen, R.S., R.D. Braddock and L.T.H. Newham (eds) 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation, July 2009, pp. 4388-4394. WOS:000290045004067

Rossa, C.G., Viegas, D.X. Propagation of wind and slope backfires. In Anderssen, R.S., R.D. Braddock and L.T.H. Newham (eds) 18th World IMACS Congress and MODSIM09 International Congress on Modelling and Simulation, July 2009, pp. 261-267. WOS:000290045000036

D.X. Viegas, L.P. Pita, K. Haddad, C. Tassini, A. Gemelli, V. Quaranta, I. Dimino, H. Tsangaris. An Innovative Approach to Forest Fires Detection and Monitoring: the EU-FIRE Project. SAFETY AND SECURITY ENGINEERING III Book Series: WIT Transactions on the Built Environment Volume: 108 Pages: 417-426 DOI: 10.2495/SAFE090391 Published: 2009 EUSAFE Conference, July, Rome. WOS:000274846500039

Courty L, Chetehouna K, Garo JP, Viegas, DX, 2010. A volatile organic compounds flammability approach for accelerating forest fires. 2nd International Conference on Modelling, Monitoring and Management of Forest Fires 2010, Kos, GREECE, JUN 23-25, 2010. WIT Transactions on Ecology and the Environment Volume: 137 Pages: 221-232 DOI: 10.2495/FIVA100201. WOS:000309430400020

Miranda, A. I.; Martins, V.; Cascao, P.; Amorim J. H., Valente J., Tavares R., Tchepel O., Borrego C., Cordeiro C. R., Ferreira A. J., Viegas D. X., Ribeiro L. M. & Pita L. P. , 2010. Monitoring fire-fighters' smoke exposure and related health effects during Gestosa experimental fires. 2nd International Conference on Modelling, Monitoring and Management of Forest Fires 2010 Location: Kos, GREECE Date: JUN 23-25, 2010. WIT Transactions on Ecology and the Environment Volume: 137 Pages: 83-94 DOI: 10.2495/FIVA100081 . WOS:000309430400008

Sharples JJ, Viegas, DX, McRae R, Raposo J, Farinha H , 2011, 'Lateral bushfire propagation driven by the interaction of wind, terrain and fire', in Proceedings of MODSIM2011, 19th International Congress on Modelling and Simulation, Australia, Perth, 12-16 December 2011. WOS:000314989300027

C. R. Ruivo, J. J. Costa, A. R. Figueiredo, Effectiveness Parameters for the Heat and Mass Transfer in a Desiccant Wheel, Diffusion in Solids and Liquids VI. 6th International Conference on Diffusion in Solids and Liquids Location: Paris, FRANCE Date: JUL 05-07, 2010 - Defect and Diffusion Forum, 2011, Vols. 312-315, pp 205-210. WOS:000297606300036

9.4.6 New materials, devices, products and processes

Roof Testing Device - This original structure was built using the resources of ADAI with the purpose of studying the impact of a forest fire on the cover (roof) of a house or rural construction. The structure allowed the construction of roofs with different materials namely tiles and shingles of various sizes and angles of inclination. This structure associated to the Combustion Tunnel of LEIF allowed the performance of a series of tests of fire impact on roofs for various test conditions.

Burning Particle Generator Device - System to generate burning particles that are projected as a jet or shower of

embers resembling those that are produced in very intense forest fires. This device was built as part of a master program by a student and it is similar to a device built at NIST (US). The system has a gas burner that is fed with wood pellets and is used to test response of materials to burning embers.

9.4.7 Software, computer code and algorithms

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

Viegas DX (Ed.), 2009. Recent Forest Fire Related Accidents in Europe. JRC Scientific and Technical Reports, Joint Research Centre, Institute for Environment and Sustainability, European Commission. JRC 56107, EUR 24121 EN, ISBN 978-92-79-14604-6, ISSN 1018-5593. 75p.

Viegas DX (Editor), Proceedings of the VI International Conference on Forest Fire Research (Nov. 15-18, 2010, Coimbra, Portugal), Viegas, D.X. (ed.), ADAI. Abstract book and CD-ROM. ISBN 978-989-20-2157-7.

Viegas DX. 2009. Cercados pelo Fogo, Parte 2. Editorial Minerva, Coimbra, 351 pp.

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

Viegas, D.X., 2008. A Situação dos Incêndios Florestais em Portugal após 2003. In Incêndios Florestais 5 anos após 2003. Editores: Joaquim S. Silva, Ernesto de Deus and Lúcia Saldanha. Liga para a Protecção da natureza, Autoridade Florestal Nacional. ISBN: 978-972-98961-8-7, 207 páginas.

Campos J. and Góis J. C., 2011. Explosivos industriais destinados a munições pesadas- 1950-1975, capítulo 5 "Eng. Química", tendo por base os textos da Conferência existente na 4ª Conferência de 1 a 2 de Abril de 2009 - Livro "Ciência e Tecnologia de Defesa" ed. pelo Núcleo Conferências da Cooperativa Militar, 2011.

Viegas D.X., 2011. Forest Fire Behaviour. In: Amorim J.H. et al. (Eds), Forest Fires research: beyond burnt area statistics. Universidade de Aveiro, CESAM, 21-26.

Viegas D. X., 2009. Wildfire Research, a state-of-the-art. Workshop on Wildfire Research: how to integrate different research fields? 6th Mediterranean Combustion Symposium, Porticcio, Corsica - France, 7-11 June 2009.

Viegas DX, 2010. Forest Fires. Keynote Lecture. In Proceedings of the Sixth Fire and Explosion Hazards Seminar. University of Leeds, 11-16th April 2010.

Viegas D. X., 2011. Overview of Forest Fire Propagation Research. 10th International IAFSS Symposium, June 19-24, 2011, College Park, Maryland, USA.

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

Recording of a series of documentaries to disseminate the research activities of the Faculty of Science and Technology for a program entitled "Republic of Knowledge" issued by Channel 2 of National Radio and Television (RTP). Three pieces were recorded one on the FCT projects "Spotfire" and "Extreme Fire Behaviour", a second on the EU project ARCFUEL and a third one on the Forest Fire Research Laboratory and its activities. These films were recorded on the 27th February 2012.

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

9.4.17 Organisation of scientific dissemination activities

Conference on NLW - Non Letal Weapons, 26th EWG NLW Meeting. The official host: ADAI and Ministério da Administração Interna, 24th-26th March 2009, Lisbon

The Seventh Biennial International Conference New Models and Hydrocodes for Shock Wave Processes in Condensed Matter. Organized by I. Plaksin (Conf. Chair); R. Mendes and J. Baranda, held in Estoril, Lisboa 18 - 23 Maio de 2008, 120 participants.

VI International Conference on Forest Fire Research. Coimbra 15 to 18th November 2010.

6th International Short Course on Fire Behaviour. Coimbra 13-14 November 2010.

3rd International Short Course on Fire Safety. Coimbra 12-13 November 2010.

2nd International Conference on Explosive Education and Certification of Skills, Lisbon, Portugal, 21st September 2011. Organizing Committee.

6th European Symposium on Non Letal Weapons, May 16-18 2011, Ettlingen, FRG: Programme Committee Member

9th Asia-Oceania Symposium on Fire Science and Technology, 17-20 October 2012, Hefei 230026, China. (Technical Committee)

International Congress "Fire Computer Modeling", FCM 2012, Universidad de Cantabria, Santander, 18-19th October 2012 (Scientific committee).

Curso sobre os incêndios na interface urbano florestal (Short-Course Forest Fires at the Urban Wildland Interface), DEM, Coimbra, 29 de Abril de 2011.

9.4.18 Research contracts with national or international entities

Contract for the Analysis and characterization of the Urban-Wildland Interface problem in Portugal. Proposition measures to minimize impact of fires in those areas. National Forestry Authority, 2008.

Contract Non-Lethal Weapons - Destructor of the Improvised Explosive Devices (IED). Funding: Portuguese Min. of Interior. 2008-2001. Objectives: development of portable techniques based on explosively accelerated water jet containing multiple projectiles; elaboration of portable devices for neutralization of IED through explosion-free demolition of the IED's hazard components.

Contract with Sociedade de Explosivos Civis, S. A - The work with SEC was focused on the development of an innovative technique for the production of nanostructured aluminum oxide powders using detonations which is already patented. Following that first stage the work was then focused on the industrialization of the technique, including the design of the reactor and all the control equipment. Going on collaborative projects are now being focused for the production and characterization of novel metal oxide powders.

Contract with IDD - Indústria de Desmilitarização e Defesa - The work with IDD was, and is, focused on the energetic and environmental valorization demilitarized energetic materials by its re-use in explosive compositions for civil application.

Contract for Training with the National Fire Brigade School, on Fire Behaviour and Fire Safety. Several training sessions of half day including theoretical and practical work at the Fire Laboratory are given

Contract for the Development and Optimization of Portable Neutralizers of the IEDs. Project Coordinator: Dr. Igor Plaksin, 2009-2013, ADAI-UC & Portuguese Ministry of Interior.

Contract ERM - Environmentally Responsible Munitions. EDA (European Defense Agency) Project involving Portugal, France, Netherlands, Germany, Norway, Romania and UK (Lead). Start date : Fev. 2011, Duration: 36 months

Controlling the Initiation Sensitivity and the Detonation Performance of Crystalline Explosives Subjected to Shock or Impact. Office of Naval Research; USA (Grant Number N00014-08-1-0096), AEM/AC. 2008-2011.

Contract for the Analysis of the Large Fire of Tavira/São Brás de Alportel. Portuguese Ministry of the interior September 2012,

Contract with Enterprise - ADF - Antonino Dias Fernandes - The main objective of the work developed for the ADF was focused on the evaluation of the performance of solid fuel fired roomheaters and its accordance with the European standard.

9.4.19 Projects funded in national and international competitive calls

Project EU-FIRE - Innovative Optoelectronic and Acoustic Sensing Technologies for Large Scale Forest Fire Long Term Monitoring. Project EU, IST-5-035299, 2006 to 2009.

Project ArcFUEL - Mediterranean Fuel Maps Geodatabase for Wildland & Forest Fire Safety. Project EU, LIFE10 ENV/GR/617, 2009 to 2011.

Project CRISMA - Modelling crisis management for improved action and preparedness. Project EU, Contract 284552, 2012 to 2015.

Project: Linking the macro and micro phenomenological scales of the mechanical behaviour of syntactic foams. Funding FCT: 17 KE, POCTI/EME/55398/2004, 2007 to 2010.

Project: Development of an experimental facility for characterization and study of domestic thermal equipment for burning solid fuels. General Objective: Design and build an experimental facility for testing the operation of domestic thermal equipment for burning solid fuels in order to support the choices to be made in the development phase. Funding QREN - ADF: 18KE, GATS08-2007-016, 2008 to 2009.

Project FIRETRECK, Fire Detection and Monitoring. Objectives: Develop localized wireless monitoring infrastructure connected to a central system able to analyze, in real time, a set of parameters. These parameters are used in a decision platform able to identify potential risk situations. Project QREN. Contract 2009/003477, Total Funding: 54KE-Average funding/year:24KE, 2009 to 2011.

Project SPOTFIRE, Analysis of Spotting Mechanism in Forest Fire Propagation. Funding: FCT, 2009 to 2011.

Project: CROSSFIRE, Cooperação de Recursos Online para Suporte e Simulações de fogos Florestais. Objectives: Development of parallel computing based system to assist fire behavior modeling and support decision making. Funding: FCT. GRID/GRI/81795/2006, 2007 to 2010.

Project EXTREME - Predição do Comportamento Extremo de um Incêndio Florestal. Funding: FCT, Contract PTDC/EME-MFE/114343/2009, 2011 to 2013.

Project nG2P- Estratégias de produção de nano-partículas de óxidos metálicos baseadas em técnicas do tipo gás-partículas. Synthesis of new materials using shock and detonation process (PTDC/EQU-EPR/114990/2009) - in cooperation with PROFEQ/LEDAP/ADAI, Funding: FCT, 2011 to 2014.

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

Forest Fires and Detonics Group (FFDG) is organized around two research teams one dedicated to forest fires that is designated Center for Forest Fires Research (CEIF) and another dedicated to Energetic Materials and Detonics that is designated as Center for Energetic Materials and Detonics (CEMDet). These two Teams work together in combustion and energetic materials and processes.

FFDG manages two experimental research facilities that are unique in Portugal: the Forest Fire Research Laboratory and the Energetics and Detonics Laboratory.

FFDG is managed by the following bodies:

- Group Direction
- Scientific Committee
- Group Plenary
- Research Teams
- Administrative and Technical support.

The Group Direction is composed by:

Group Leader: Domingos Xavier Viegas (Forest Fires)

Sub-leader: José Baranda Ribeiro (Detonics).

Secretary: A. Rui Almeida Figueiredo.

Fire Research Laboratory Manager: Miguel Almeida

Detonics Laboratory Manager: José A. Campos.

The Group Direction is in charge of managing the funds and all human and material resources available to the Group. It is also in charge of representing the Group internally in LAETA meetings and externally in activities involving third partners.

The Scientific Committee is composed by all the integrated members of the Group. This Committee meets regularly to organize the assignment of human and material resources, to prepare new proposals, reports of activities and work plans.

The Group Plenary is composed by all researchers holding a Masters degree working in the Group. This assembly meets annually to discuss the research report of the past year and the program for next year.

The research Teams are composed by the specialized members of CEIF and CEMDet. They meet regularly on a weekly basis to discuss and plan ongoing work.

The Administrative and Technical support is given by the elements of ADAI Secretariat assisted by a specialized financial support enterprise. We have also a Laboratory Technician dedicated specifically to the forest Fire Laboratory.

9.5.2 Objectives of the Research Group

The Forest Fires and Detonics Group (FFDG) objectives for the period from 2015-2020 are the following:

General objectives:

- Contribute to improve the scientific knowledge in the fields of forest fires and Detonics in collaboration with several national and international institutions.
- Promote conditions to attract and host high quality research students and to train them in the context of academic or professional advanced training programs with the support of research contracts.
- Promote dissemination of knowledge and exploitation of research outcomes in the scientific community to industrial partners and to operational bodies.

- Improve the capacity of LAETA to better serve the Country at a level of excellence in this field of research.

Specific Objectives in Forest Fire Research:

- Maintain the existing data base on fuel moisture of fine forest fuels common in Central Portugal that was created in 1987.
- Develop research on forest fuel modeling and characterization namely on fuel moisture modeling and on combustibility of heterogeneous fuels
- Investigate extreme fire behaviour modes namely eruptive fires, crown fires, spot fires, jump fires and fire whirls.
- Investigate issues associated to safety of persons and assets subject to fire impact
- Work with the industry and with the authorities to develop innovative projects of fire protection. Develop cases studies and system performance assessment.
- Improve the test conditions and the equipment of the Fire Laboratory to have better research conditions to attract high quality researchers, industry contracts and research grants.

Specific Objectives in Detonics Research

- To proceed with fundamental research of the detonation phenomena to support advances in modeling and the development of safer (insensitive) energetic materials and more effective defense artifacts.
- To proceed with the development and improvement of models and tools, including the numerical ones, for the simulation and characterization of the detonation process in all its phases.
- To proceed with a theoretical, modeled, and experimental supported development of advanced energetic materials.
- To proceed with fundamental and applied research for the improvement of tools regarding the assessment of environmental and toxicity impacts and the development of new disposal paths of energetic materials and defense artifacts.
- To proceed with the applied research regarding the use of the explosive generated shock waves for high-energy rate processing of materials.
- To deepen the collaboration with industry and defense institutions in the field of: a) the detonation synthesis of metal oxide powders; b) ammunition disposal technology and c) lifetime assessment of energetic materials.
- To strength the relationships with European, North American and Brazilian research centers in the area of the physics and chemistry of shock and detonation waves.
- To enlarge the experimental research capabilities with a spectrometer to coupled with the existing electronic streak cameras.

(RG-50022-1630) Aeronautics and Astronautics

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-1630

9.1.2 Name of the Research Group in portuguese

Aeronáutica e Astronáutica

9.1.3 Name of the Research Group in English

Aeronautics and Astronautics

9.1.4 Keyword(s)

Multidisciplinary Optimization

Flight Dynamics and Optimal Control

VSTOL, Aerodynamics and Propulsion

Satellites

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator	Nuclear CV
Kouamana Bousson	Yes	Yes
Jorge Manuel Martins Barata	No	Yes
Vasili Andreevich Sarychev	No	Yes
André Resende Rodrigues Silva	No	No
José Miguel Almeida da Silva	No	No
Pedro Vieira Gamboa	No	No
Francisco Miguel Ribeiro Proença Brojo	No	No
Jorge Miguel dos Reis Silva	No	No

9.2.2 List of current PhD students

NAME

Christian Michel Gomes Rodrigues
Eduardo Luís Santos Farias Antunes
Diana Filipa da Conceição Vieira
Pedro Alexandre Rodrigues Manquinho
Carlos Miguel Nóbrega Velosa
Paulo Filipe Faria Machado
Sandra Clara Rodrigues Antunes
Pedro Daniel da Rocha Santos
António Luis Martins Mendes
Luis Filipe Ferreira Marques Santos
Marlene da Conceição da Silva Gonçalves
Maria Emília da Silva Baltazar
Pedro Filipe Fernandes de Albuquerque
Filipe Couceiro Malta da Costa Potes
Jorge Manuel Pereira Gregório

9.2.3 List of other researchers of the Research Group

NAME

Fernando Manuel da Silva Pereira das Neves

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

The LAETA-UBI/AEROG, Aeronautics and Astronautics Research Center (AEROG) of the University of Beira Interior is dedicated to the research and technology development in the field of Aeronautics and Space, with a view to improving safety and environmental protection.

The AEROG is a Research Group (RG-Centro-50022-3875) of the LAETA-Associated Laboratory in Energy, Transports and Aeronautics (LA-LVT-22) and its Research Line of Aeronautics and Space (RL-EME-LA22-159).

The activities of the AEROG aim at contributing to strengthen the excellence of european science base in the scientific and technological fields of aeronautics and astronautics.

The AEROG research activities can be grouped within four main specific areas:

- Multidisciplinary Optimization of Aircraft Configurations;
- Flight Dynamics and Optimal Control;
- VSTOL, Aerodynamics and Propulsion;
- Satellites.

The first area deals with multidisciplinary optimization of aircraft configurations which has received special attention in the context of the international aerospace community. The second area deals with the problems associated with the increase of the substantial rise in air traffic and flight control and its implications in safety and trajectory optimization. The third area short/vertical takeoff and landing aircrafts research and it also includes the technological developments needed to reduce the fuel consumption of engines, the emissions (CO₂ and NO_x), the noise, etc. The Satellites area is of great importance in telecommunications and many other applications.

9.3.2 Main achievements

Global parameterization modeling and efficient algorithms for four-dimensional trajectory optimization and control of general purpose nonlinear dynamical systems have been conducted and tested against real-world autonomous flight scenarios. The research in the area of avionic control has also brought key issues not only in flight dynamics analysis and optimal control, but also in computing science and other connected fields in which computer-based simulation plays a fundamental role. In this specific area, aeronautical engineering students have also been involved in the intellectual challenges presented by autonomous flight control and optimal control theoretic approach to fuel saving for the betterment of social life with regard to new energy threats.

Revision of current spray models to predict the spray behaviour when impingement takes place against wetted, hot surfaces and/or the spray dynamics. Experimental data (a collaborative PhD project with IST) was used to develop and validate appropriate sub models for impingement and evaporation. Computational modelling has also been used to extend the experimental work and to obtain a detailed characterisation of the processes involved in more practical situations.

Solutions of equilibrium and stationary rotations, stability, and bifurcation in space of parameters, limit motions, and influence of perturbations for a single satellite and a system of several connected bodies subject to various torques. Characterization of the upstream part of a ground vortex resulting from the collision of a ground vortex with a crossflow with relevance for a VSTOL aircraft. A comprehensive analysis of the turbulent flow structure was conducted using turbulent energy budgets derived from the experimental data.

A variable-span morphing wing was designed through multidisciplinary design optimization techniques, implemented and ground tested. Numerical and experimental results showed that the system is suitable for increasing overall flight efficiency and roll control. These results are the motivation to study the concept further through flight tests on a UAV prototype.

Preliminary numerical results have been obtained envisaging the minimization of aeroelastic problems in aircraft structures through the use of both active and passive solutions. In the former case, smart materials (such as PZTs) have been considered for active vibration control, whereas the improvement of the damping properties of structures has been achieved based on viscoelastic materials (such as cork composites) in the latter case.

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

Sarychev V. A., Mirer S. A., and Degtyarev A. A., "Equilibria of a satellite subjected to gravitational and aerodynamic torques with pressure center in a principal plane of inertia". *Celestial Mechanics and Dynamical Astronomy*, 2008, Vol.100, No.4, pp.301-318 DOI: 10.1007/s10569-008-9126-9 (ISSN 0923-2958, IF 1.175, C 4).

Barata, J.M.M., Ribeiro, S., Santos, P. e Silva, A.R.R., "Experimental Study of a Ground Vortex". *Journal of Aircraft*, Vol. 46, N^o4, Jul./Ago. 2009, pp.1152-1159 DOI:10.2514/1.36619 (ISSN 0021-8669, IF 0.632, C 1).

Gamboa, P., Vale, J., Lau, F., and Suleman, A., "Optimization of a Morphing Wing Based on Coupled Aerodynamic and Structural Constraints", *AIAA Journal*, Vol. 47, No. 9, September 2009, pp. 2087-2104 DOI:10.2514/1.39016 (ISSN 0001-1452, IF 1.080, C 13).

Bousson, K., Antunes, S. C .R. "Optimal Feedback Control Approach to Pattern Signal Generation with Chua-Matsumoto's Chaotic Oscillator", *International Review of Electrical Engineering-IREE*, Vol. 5, No.1, February 2010, pp. 304-310 (ISSN 1827-6660, C 1).

Silva, J.M., Nunes, C.Z., Franco, N., P.V. Gamboa, P.V., "Damage tolerant cork based composites for aerospace applications", *The Aeronautical Journal*, Vol. 115, No 1171, 2011, pp. 567-575 (ISSN 0001-9240, IF 0.311).

Bousson, K., "Synchronization of a Chaotic Gyroscopic System under Settling Time Constraints". *Journal of Vibroengineering*, Vol. 14, No. 3, September 2012, pp. 1299-1305, (ISSN 1392-8716, IF 0.350).

Barata, J.M.M. Rodrigues, C.M.G. and Silva, A.R.R., "Liquid Film Dynamic on the Spray Impingement Modelling. Atomization and Sprays, Vol. 22, Issue 8, December 2012 DOI: 10.1615/AtomizSpr.2012006400 (ISSN 1045-5110, IF 0.928).

Rodrigues, C.V.C, Silva, J.M.R and Bousson, K. (2012) Advanced air traffic management technologies: the ADS-B impact over ATM concepts. The case for Portugal, *International Journal of Aviation Management*, Vol. 1, Issue 3, 2012, pp 162-180 (ISSN 1755-990).

Bousson, K., "Synchronization of a Chaotic Gyroscopic System under Settling Time Constraints". Journal of Vibroengineering, Vol. 14, No. 3, September 2012, pp. 1299-1305, (ISSN 1392-8716, IF 0.350).

Páscoa, J. C., Mendes, A. C., Gato, L. M. C. "A Fast Iterative Inverse Method for Turbomachinery Blade Design", Mechanics Research Communications, 36, 2009, pp. 630-637 DOI:10.1615 (ISSN 0093-6413, IF 1.085).

9.4.2 Completed PhD theses

Miguel Ângelo R. Silvestre, "Estudo da Interação entre um Jacto de Parede e uma Camada Limite", 2009.

Fernando M. S. P. Neves, "Aerodynamic Control of the Mixing of Confined, Plane and Co-axial ", 2012.

9.4.3 Patents and Prototypes or other research outputs

4D Flight Trajectory Guidance and Control Simulator, Version 1, Covilhã, Portugal, 2012. (Computational Application in the X-Plane Environment).

Variable-Span Morphing Wing Prototype, Covilhã, 2012. (prototype).

Olharapo - An Unmanned Aerial Vehicle for Developing and Testing Morphing Concepts, Version 2, Covilhã, 2010. (prototype).

Variable Camber Flap for Improved Aerodynamic Performance with Reduced Actuation Energy, Covilhã, 2009. (prototype).

Method for Measuring and Monitoring Physiological Parameters of Aircraft Pilots Ultra Light in Real Time. Provisional Patent Application no. ° 106148.

9.4.4 Books and book chapters of international circulation

Barata, J.M.M. and Silva, A.R.R., "Numerical Simulation of Biofuels Injection", in Fuel Injection in Automotive Engineering, Prof Kazimierz Lejda (Ed.), pp.127-144, ISBN: 978-953-51-0528-2, InTech, 2012.

Fael, P., Santos, F., Pontes, B., Brójo, F., Páscoa, J., Correia, L., Alves, C., Rodrigues, N., "Design and Construction of a Car Body in Fiber Glass - Case Study", in the book Transactions on Transport Systems, Telematics & Safety, Poland, Publishing Company "Silesian University of Technology", 2011, pp.151-149, ISBN 978-83-7335-824-9.

Branco, R., Antunes, F.V., Ferreira, J.A.M., Silva, J.M.; "Effect of Residual Stresses on Crack Shape of Corner Cracks at Holes in Nickel Base Superalloys"; Superalloys: Production, Properties and Applications; Jeremy E. Watson (Ed.); Nova Science Publishers; 2011; ISBN: 978-1-61209-536-3

Okhotsimsky, D. E., Eneev, T. M., Akim, E. L., Sarychev, V. A. "Applied celestial mechanics and investigations of space". In the book "Applied celestial mechanics and motion control", Moscow, Publishing Company "Izvestia", 2010, pp.327-366 (In Russian).

Sarychev, V. A. "Okhotsimsky and his contribution in passive control systems of satellites". In the book "Applied celestial mechanics and motion control", Moscow, Publishing Company "Izvestia", 2010, pp.223-271 (In Russian).

Saúde, J.L., Silva, J.M.R. "Commercial Aircraft: A Holistic and Integrated Model of the Flux of Information Regarding the Operational Support", in "Computational Models, Software Engineering, and Advanced Technologies in Air Transportation: Next Generation Applications" (Chapter IX), Edited by: Li Weigang, University of Brasilia, Brazil; Alexandre de Barros, University of Calgary, Canada; Italo Romani de Oliveira, Atech Tecnologias Críticas, Brazil, October 2009, ISBN: 978-1-60566-800-0.

Mendes, A.L.M., Barata, J.M.M., Gebrekidan, M. "Design Against Failure with Today's Technology", in "Integrity, Reliability and Failure", Edited by: J.F. Silva Gomes and Shakar A. Meguid, Porto, Portugal, July, 2009, ISBN 978-972-8826-21-5.

Sarychev V. A., "Systems of passive orientation for artificial satellites. In the book "Future of Applied Mathematics", Moscow, Russia, 2008, pp.116-182 (in Russian).

Páscoa, J. C., Mendes, A. C., Gato, L. M. C. (2008): "Redesigning Annular Turbine Blade Rows Using A Viscous-Inviscid Inverse Design Method". Proceedings of the Gas Turbine Technical Congress and Exposition, (ISBN 0-7918-3824-2), Vol. 6, pp. 2209-2217, ed. American Society of Mechanical Engineers, International Gas Turbine Institute, Berlin, 9-13 June, 2008

F. Santos; F. Brójo, P. Vilarinho, "Lot Sizing and Scheduling in Parallel Uniform Machines - A Case Study" in the book Simulated Annealing - Advances, Applications and Hybridizations, Edited by Marcos de Sales Guerra Tsuzuki, Published by InTech, 2012, pp. 151-178, ISBN 978-953-51-0710-1.

9.4.5 Conference proceedings

11th International Conference on Combustion and Energy Utilization - ICCEU, Coimbra, Portugal, 9-13 Maio, 2012.

International Conference on Engineering, ICEUBI2011, Covilhã, Portugal, 28-30 November, 2011.

9.4.6 New materials, devices, products and processes

9.4.7 Software, computer code and algorithms

4D Global Flight Collision Avoidance Simulator for Unmanned Aerial Vehicles, Version 1, Covilhã, Portugal, 2012. (Computational Application).

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

"Propulsão, Vol.3-Motores Alternativos de Combustão Interna", ISBN-978-989-654-070-8, Ed. Serviços Gráficos da Universidade da Beira Interior, Covilhã, 2011.

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

Fuel Processing Technology (ISSN 0378-3820), Elsevier, "Managing Guest Editor of Special Issue: 11th ICCEU", 2011-2012.

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

9.4.17 Organisation of scientific dissemination activities

11th International Conference on Combustion and Energy Utilization - ICCEU, Coimbra, Portugal, 9-13 Maio, 2012 (Organizing Committee).

International Conference on Engineering, ICEUBI2011, Covilhã, Portugal, 28-30 November, 2011 (Organizing Committee).

Organizing Committee, Engenharia'2009 Inovação e Desenvolvimento, UBI, Covilhã, 25-27 November, 2009 (Organizing Committee).

52nd ERSA - Regional Science Association International Congress, Bratislava, Slovakia, 21st - 25th August 2012 (Scientific Committee).

Modeling and Applied Research on Advances in Spatial Development Accessibility Joint Meeting: 5th Seminar on Spatial Econometrics in Honor of J. Paelinck / Nectar Cluster 6 Meeting on Accessibility, Coimbra, University of Coimbra, 26th and 27th October 2012 (Scientific Committee).

XI SITRAER - Simpósio de Pesquisa em Transporte Aéreo da Sociedade Brasileira de Transporte Aéreo (SBTA), Brasília, 20th - 22nd November 2012 (Scientific Committee).

NECTAR (Network on European Communications and Transport Activity Research) Cluster 1 Meeting on Crucial Networks for Peripheral Territories, University of Azores, 16th and 17th September 2011 (Scientific Committee).

X SITRAER - Simpósio de Pesquisa em Transporte Aéreo da Sociedade Brasileira de Transporte Aéreo (SBTA), Ouro Preto, Brasil, 23rd - 26th November 2011 (Scientific Committee).

IX SITRAER - Simpósio de Pesquisa em Transporte Aéreo da Sociedade Brasileira de Transporte Aéreo (SBTA), Manaus (Brasil), 27th - 29th October 2010 (Scientific Committee).

Workshop of AIRDEV - Business Models for Airport Development and Management (Project: MIT-pt/TS-AAS/0046/2008), about Airport Development, Lisbon, 20th October 2011 (Scientific Committee).

9.4.18 Research contracts with national or international entities

"Electric Long Endurance UAV". LAETA collaborative project including the groups CCTAE, IDMEC, AEROG and INEGI. Portugal, 2011-2014. (Budget: 26 724 €).

"Segurança contra Incêndios em Parques de Campismo e Caravanismo". LAETA collaborative project including the groups ADAI, CCTAE, IDMEC, INEGI and AEROG. Portugal, 2011-2014. (Budget: 55 296 €).

"Multi-Scale Analysis and Optimization of Advanced Composites with Application to Greening Aircrafts". LAETA collaborative project including the groups CCTAE, IDMEC and AEROG. Portugal, 2011-2014. (Budget: 25 945 €).

"Tecnologias Biomiméticas para a Aerodinâmica de Micro-Veículos Aéreos". LAETA collaborative project including the groups CCTAE, IDMEC, and AEROG. Portugal, 2011-2014. (Budget: 15 922 €).

"SGNOP - Serious Game - Naval Operations", N° 012315, funded by the QREN Program. June 2010 - June 2012. Contractor: EMPORDEF (Lisbon). (Budget: 27 965€).

9.4.19 Projects funded in national and international competitive calls

"Turbulent Structure of the Impact Zone of a Ground Vortex Flow". PROJECTO FCT PTDC/EME-MFE/102190/2008 Portugal, 2011-2014. (Budget: 60 000 €).

"CHANGE - Combined morphing Assessment software using flight Envelope data and mission based morphing prototype wing development" funded by the European Commission (Transport including Aeronautics - Collaborative Project Level 1 - Part B, ACP2-GA-2012-314139-CHANGE-GA) through FP7, August 2012 - 31 July 2015. (Budget: 4 886 469 €).

"DesAIR: Design of Environmentally-friendly Structures for Aircrafts". Project Ref. 24557, under the support of FEDER (Programa Operacional Factores de Competitividade), July 2012 - December 2014, (Budget: 694.787,03 €).

"SIMUAV - Design and Implementation of a Simulator for Unmanned Aerial Vehicles", Ref. 70/2007/3.1B/00330/0061, funded by the Portuguese Innovation Agency (ADI: Agência de Inovação). March 2007 - June 2008. Other participants: Critical Software (Lisbon & Coimbra), University of Coimbra. (Budget: 135 860 €).

"AIRDEV - Business Models for Airport Development Management", Ref. MIT-pt/TS-AAS/0046/2008, funded by FCT in the Framework of MIT-Portugal Agreements. Other Participants: Alstom (Saint-Ouen), FEUP - Faculdade de Engenharia da UP (Porto), INAC (Lisboa), FCTUC (Coimbra), University of Antwerp. September 2009 - December 2012. (Budget: 183 144 €).

"Dimensión y Tipología de los Movimientos Transfronterizos en la Frontera entre España (Extremadura-Huelva) y Portugal (Alentejo-Algarve)". Ref. FM/2251/2006 (Ministerio de Fomento de España). January 2006 - June 2010. Other participants: IST (Lisbon), Fundicotex (Espanha), Planicôa (Guarda), e Parques Tejo (Oeiras, Lisbon). (Budget: 12 844 €).

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The hosting institution of the LAETA-UBI/AeroG research group is the University of Beira Interior. The main activities of the research group consist in strengthening the excellence of European science foundations in aeronautics and astronautics and contributing to the implementation of the European Higher Education Area. Hence, the AeroG research group is composed of full member research scientists as well as collaborating members, including graduate students and research fellows, involved in scientific and engineering research and development activities.

The research group is led by a scientific coordinator and has a Scientific Council and a Permanent Scientific Advisory Board as described below:

Scientific Coordinator:

1. The Scientific Coordinator is elected by the members of the Scientific Council.
2. The Scientific Coordinator performs his duties in accordance with Research Unit Regulations laid down by the MCTES concerning the multiannual research unit funding.
3. The Scientific Coordinator represents the research group at all levels.
4. The Scientific Coordinator sets the research policy of the research group.

The Scientific Council consists of researchers with PhD degree. It proposes the admission or withdrawal of members, and deals with the financial and annual activity reports.

Permanent Scientific Advisory Board:

1. The Advisory Board is composed of individuals who were recommended by the Scientific Coordinator and operates

in accordance with the Regulations that have been established by the MCTES regarding multiannual research unit funding.

2. The Advisory Board issues each year a detailed and justified opinion about the strength of AeroG activities, signed together or separately by at least two of its members.

The admission of new AeroG members is made on a proposal from any member of the Scientific Council and requires the approval of the AeroG Scientific Coordinator.

The AeroG research group sets yearly an auto-evaluation period of its activities focusing on the following aspects:

1. Compliance with the objectives that were stated by the research group;
2. Scientific and technical performance with respect to LAETA's research criteria and guidelines;
3. Cost-profit trend of each activity;
4. Optimization of management activities.

9.5.2 Objectives of the Research Group

For the forthcoming 2015/2020 research period, the activities of the AeroG group will keep on contributing to strengthen the excellence of European science foundations in the scientific and technological fields of aeronautics and astronautics.

The research activities of the group will focus on the following four main specific areas:

- Aerodynamics and Propulsion;
- System Dynamics and Optimal Control;
- Infrastructure and Sustainability;
- Aerospace Vehicle Design.

The area of "Aerodynamics and Propulsion" includes short/vertical take-off and landing aircraft research, as well as the technological developments needed to reduce the fuel consumption of engines, the emissions (CO₂ and NO_x), noise and related environmental issues. As to "System Dynamics and Optimal Control", the research activities will focus on 4D trajectory generation, optimization and optimal control for fuel saving, air collision avoidance and robust automatic flight control against disturbances and model uncertainties. Besides, chaotic dynamics will be dealt with in view of the increasing complexity of aerospace dynamical systems. The area of "Infrastructure and Sustainability" is concerned with the general scientific domain of transportation with regard to national or regional development, focusing on the aerial component in particular, and mainly with regard to operational research, economics, air transport management, aircraft operations, and flight safety and security. The "Aerospace Vehicle Design" research activities will deal with the following issues: the development and characterization of new materials for aerospace applications, the optimized design of aircraft and aerospace structures, and the structural integrity assessment based on real case scenarios.

(RG-50022-2178) Experimental Mechanics New Materials and Manufacturing

9.1. IDENTIFICATION OF THE RESEARCH GROUP

9.1.1 Reference of the research group

RG-50022-2178

9.1.2 Name of the Research Group in portuguese

Mecânica Experimental Novos Materiais e Processos de Fabrico

9.1.3 Name of the Research Group in English

Experimental Mechanics New Materials and Manufacturing

9.1.4 Keyword(s)

Experimental Mechanics and Structural integrity

Advanced Materials and new production technologies

Tribology Vibrations and Industrial Maintenance

Advanced design for Bioengineering and aeronautics

9.1.5 Existed in 2008/2012

Yes

9.1.6 Participating Institution(s) to which the Research Group belongs

Instituto de Engenharia Mecânica e Gestão Industrial (INEGI/UP)

9.2. RESEARCHERS IN THE GROUP

9.2.1 List of Integrated Members / 3 nuclear CVs

Name	Principal Investigator Nuclear CV	
Mario Augusto Pires Vaz	Yes	Yes
Alberto Sérgio de Sá Rodrigues Miguel	No	No
André Ricardo Maia Correia	No	No
Fernando Jose Ferreira	No	No
Hernani Miguel Reis Lopes	No	No
JAIME MIRANDA MONTEIRO	No	No
João Carlos Antunes Sampaio Fernandes	No	No
João Carlos Gonçalves Ferreira de Pinho	No	No
José Castela Torres da Costa	No	No
João Eduardo Pinto Castro Ribeiro	No	No
Jose Augusto Goncalves Chousal	No	No
José Carlos Reis Campos	No	No
Maria Arcelina Marques	No	No
Maria Helena Guimarães Figueiral da Silva	No	No
Paulo Jose da Silva Tavares	No	No
Patricia Alexandra Barroso da Fonseca	No	No
Pedro Miguel Guimarães Pires Moreira	No	No
Sérgio Manuel Oliveira Tavares	No	No
João Manuel Abreu dos Santos Baptista	No	No
João Manuel Ribeiro da Silva Tavares	No	No
Antonio Paulo Monteiro Baptista	No	No
Armando José Vilaça de Campos	No	No
Carlos Pinto Moreira de Sá	No	No
Francisco José Gomes da Silva	No	No
Jorge Humberto Oliveira Seabra	No	Yes
José Augusto de Sousa Ferreira Brandão	No	No
José Fernando Dias Rodrigues	No	No
Luís António de Andrade Ferreira	No	No
Luis Manuel Martins Leite de Magalhaes	No	No
Manuel Jorge Dores de Castro	No	No
Pedro Manuel Leal Ribeiro	No	No
Ramiro Carneiro Martins	No	No
Rui Pedro Cardoso Silva Martinho	No	No
Abel Dias dos Santos	No	No
ana rosanete lourenco reia	No	No
ANTONIO JOSE CAETANO BAPTISTA	No	No

Augusto Duarte Campos Barata Rocha	No	No
Carmen Marisa Marques Gonçalves	No	No
Fernando Jorge Lino Alves	No	No
José Manuel Estevão Costa	No	No
José Manuel Lopes Teixeira Amarante	No	No
Luis Manuel dos Santos Redondo	No	No
Manuel António Pereira Gutierrez	No	No
Marta Ilda Laranjeira Lopes de Oliveira	No	No
Nannan Song	No	No
Pedro Manuel Cardoso Teixeira	No	No
Teresa Margarida Guerra Pereira Duarte	No	No
André Ferreira Costa Vieira	No	No
antonio joaquim mendes ferreira	No	No
António Rui de Oliveira Santos Silva Melro	No	No
Antonio Torres Marques	No	Yes
Carla Maria da Cunha Roque	No	No
Celeste Margarida Correia Pereira	No	No
César Miguel de Almeida Vasques	No	No
Claudio Saul Faria Lopes	No	No
Cristina Maria Nogueira Romão	No	No
Maria Cristina dos Santos Ribeiro	No	No
Hugo Queiros de Faria	No	No
Jaime Duarte Rodrigues	No	No
José Luís Soares Esteves	No	No

9.2.2 List of current PhD students

NAME

Viviana Maria de Oliveira Correia Pinto
Antonio Pedro Dinis Paiva
Carlos Miguel da Costa Gomes Fernandes
David Emanuel Pimentel Gonçalves
Pedro Miguel Teixeira Marques
Luis Carlos da Silva Mendes Cardoso
Rafaela Carla Barros Casais
Inês Vieira Oliveira
Joana Maria Marques do Vale
João Paulo Geraldês Touro Pereira
Paulo Júlio Andrade de Almeida
André Magalhães Sá Camboa
Marta Carvalho da Silva e Sousa
Tiago Miguel Ribeiro Marques
Cristiano José Pereira Coutinho
Joana Carvalho dos Santos

9.2.3 List of other researchers of the Research Group

NAME

Rui Paulo Soares Ribeiro
Nuno Viriato Marques Ramos
Joaquim Pedro Pinto Couto Viana
Alexandre Goncalves dos Santos de Santiago Sottomayor
André Lopes Gama
Beatriz Maria da Mata Graça
Tiago Cousseau
Ana Rita Novais e Silva
Armanda Maria Marques Teixeira
Bártolo António Carneiro Paiva
Fernando Seabra da Silva Moreira
João Pedro Sequeria Rodrigues Ferreira Duarte
José Francisco Gonçalves Teixeira
José Manuel Duarte Oliveira
Maria Luisa Lourenço Lopes Guardão
Paulo André Pereira Machado
Ricardo José Moreira Horta Oliveira
Ricardo Mário Ribeiro Paiva
Rui Jorge de Lemos Neto
Tiago António Nunes da Silva Morais
Joaquim Francisco da Silva Gomes
Maria Helena Melo e Alvim Oliveira Miranda

9.3. RESEARCH GROUP DESCRIPTION AND ACHIEVEMENTS FOR 2008/2012

9.3.1 Description of the Research Group

Experimental Mechanics new materials and manufacturing processes includes 4 R&D units
Laboratory of Optics and Experimental Mechanics (LOME) is involved in Technologies for structural integrity/health monitoring and inspection in both static and dynamic loading, Full field methods for characterization of displacement, strain, stress and residual stress fields, Development of non-contact techniques for NDT of composites, Transient loading in metallic and composite parts and assessment of their dynamic behaviour, Adaptive components integrating sensors and actuators, optical fibres and PZTs for structural monitoring of large scale structures, pulsed Laser illumination techniques with double and multiple high speed video image recordings, Optimization and characterization of emerging joining technologies, Development of intelligent mechanical joints for on line damage detection, Hybrid numerical/experimental techniques for SIF determination, crack growth rate and structural integrity assessment, Software for 3D vision, image processing and shape characterization for metrology and medical applications, Experimental methodologies in Biomechanics and numerical simulation of living mechanisms, occupational biomechanics.

Tribology, Vibrations and Industrial Maintenance (CETRIB) is dedicated to four main R&D fields: Fundamentals of Tribology, Tribology of Machine Elements, Vibrations and Industrial Maintenance. Development of grapheme-based surface coatings (among others) for tribological applications and experimental validation, Tribofilms generated by lubricant additives, experimental analysis of nanoparticles and surface coatings using several techniques (SEM, EDS, XPS, Raman ...), Development of analytical and numerical models for study grease lubrication mechanisms (film generation, starvation, friction ...), for surface distress (wear, micro-pitting, scuffing...) and for RAMS (Reliability, Availability, Maintainability, Safety) analysis of mechanisms and industrial processes. CETRIB also performs ball-on-disc, rolling bearing, gear and gearbox tests, among many other, for the experimental validation of the models developed.

The Composite Materials Group (UMEC) has historically implemented a broad basic-science-to-application vision, involving significant laboratory means and manufacturing equipment that enable an unusual hands-on manufacturing validation, testing and demonstration capability. This capability, which includes large semi-industrial equipment, ranging

from filament winding to autoclave forming (including a class 10k clean room), pultrusion, resin transfer moulding and vacuum infusion, is complemented by analytic and mechanical testing laboratories. The activity of the Group uses this laboratory base to develop extensive analytical/numerical-experimental research in fields such as long-term performance, residual life estimation, new material/process development and modelling. This vision has moved the group towards an integrated approach where Design, Manufacturing, Assembly and Durability are considered. Applications to the transport, aeronautics and space industries are the main fields of the group.

New technologies and advanced production processes (NOTEPAP) unit is composed by researchers from the mechanical engineering, medicine, bioengineering, materials and industrial design areas. Advanced processing technologies are explored to address the following main research topics: Investment casting of reactive alloys, additive manufacturing and methodologies for custom fit prosthesis fabrication, macro and micro manufacturing processes of advanced structural materials and sustainable manufacturing. The work of the research team focus the development and adoption of such technologies to the processing of a wide assortment of advanced materials such as aluminium alloys, magnesium alloys, titanium alloys, super alloys, Invar, besides other metallic, ceramic and polymeric materials, encompassing diverse products applications.

9.3.2 Main achievements

Development of non-contact techniques for NDI of composites: laser interferometry (CW/pulsed), Digital Image Correlation, thermography. New monitoring and evaluation methods for structural integrity assessment in aircraft structures. New techniques for characterization and optimization of emerging joining technologies, intelligent mechanical joints for online damage detection, Hybrid numerical/experimental techniques for SIF determination in crack propagation. Software for Image processing in optical metrology, NDI and clinical image diagnosis. 3D Shape characterization of tissues and components. Structural monitoring for wind generators. Starting of a laboratory of biomechanics to study the human movement in rehabilitation, clinic, sports and occupational contexts. Study of human performance in harsh environments for civil and military application.

Graphene and PTFE-based polymer coatings were manufactured and tested against steel in cross cylinder configuration. Low friction (0.08) and low wear were measured in large sliding distance (2km). Grease lubrication models, based on grease bleed-oil properties, under fully flooded and starved conditions, were built and validated in ball-on-disc tests. Surface distress models (wear, micro-pitting,...), including mixed-film lubrication and multi-axial fatigue criteria (Dang Van) were developed and validated in gear tests. Gearbox power loss models were built and validated in bearing, gear and gearbox tests. Special gear tooth geometry and oil formulation were tested, leading to large friction decrease in wind turbine gearboxes. A hybrid experimental-numerical procedure to identify the complex shear modulus of viscoelastic materials was implemented, allowing the identification of the characteristic parameters of viscoelastic constitutive models. FE models and experimental testing of cork compounds used as effective passive damping, in sandwich or multilayer structures

Systems: New melting and pouring vacuum technology with cold crucible and differential pressure system. Bulge tester for sheet metal characterization and stress-strain determination

Materials: Ceramic formulations for investment casting of reactive alloys to obtain high complexity parts.

Characterization of metal-ceramic reactions (mechanical, thermal, physical)

Methodologies: Manufacturing of maxilla-facial prosthesis based on additive manufacturing, rapid tooling and/or incremental sheet forming

Product: Design and production of: extra oral prosthesis (noses, fingers and other soft tissues) and custom fit hip prosthesis

Surfaces: Laser and chemical treatment of biocompatible and bioactive materials

Software: FE-based Numerical modeling applied to metal forming processes; SW Interfaces between CAD and LCA for product/process design

Manufacturing processes: Development of the electromagnetic forming process, Laser micro-milling and micro texturing

Significant achievements of the composite research group encompass developments in new materials, prototypes, models, spin-off activities and technology transfer. Development of new space qualified carbon fibre pre-preg material in a European project which the group is leading, and tackle an existing gap in European supply. Development of new types of highly loaded nano-composites (with ESA) or new nano-based fire proofing compounds or ablative materials.

The group has also produced new models for processes, allowing in-depth understanding of processes such as filament winding or RTM as well as advanced models to understand damage propagation in composites. The group has also produced significant outcomes in technology spin-off. By assisting the set-up of companies such as Clever Reinforcements who produce carbon laminates for bridge reinforcements, Alto, HPS Pt

The scientific production of the group during 2008-2012, Books+chapter 33,Int Jour 341,Nat Journ. 39;Int Conf 543,Nat Conf 54,Int Proj 20,Nat Proj 152,Org Conf 60,Org Synp 29,Memb Edit board 90,MSc 161,PhD 18,PATENT 5

9.4. RESEARCH GROUP OUTPUT 2008/2012

9.4.1 Publications in peer reviewed journals and/or other publications

M. F. S. F. de Moura, R. D. S. G. Campilho, J. P. M. Gonçalves, "Crack Equivalent Concept Applied to the Fracture Characterization of Bonded Joints under Pure Mode I Loading", *Composites Science and Technology* 68:2224-2230, 2008. (IF=2,533) (nº C=25)

Vieira, A. C., Vieira, J. C., Ferra, J. M., Magalhães, F. D., Guedes, R. M., & Marques, A. T. (2011). Mechanical study of PLA-PCL fibers during in vitro degradation. *Journal of the Mechanical Behavior of Biomedical Materials*, 4(3), 451-460. (IF=2.368) (nº C=12)

de Moura M.F.S.F., Campilho R.D.S.G., Goncalves J.P.M., Pure mode II fracture characterization of composite bonded joints 2009, *International Journal of Solids and Structures*, (6) 1589-1595. (IF=1.809) (nº C=21)

R. Martins, R. Amaro and J. Seabra, "Influence of low friction coatings on the scuffing load capacity and efficiency of gears". *Tribology International*, Vol. 41/4 (2008), pp. 234-243. *Tribology International* / 1.423 /2008

N.F.R. Cardoso, R.C. Martins, J.H.O. Seabra, A. Igartua, X. Fdez-Pérez and R. Luther, "Micropitting performance of nitriding steel gears lubricated with mineral and ester oils". *Tribology International*, Vol. 42/1 (2009), pp. 77-87, *Tribology International* / 1.690 /2009; doi:10.1016/j.triboint.2008.05.010.

José Brandão, Jorge H.O. Seabra and Jorge Castro, "Surface initiated tooth flank damage. Part I: Numerical Model". *WEAR*, vol. 268 (1-2), 2010, 1-12. *Wear* / 1.635 /2010; doi:10.1016/j.wear.2009.06.020.

Santos João P., Oliveira Marta, Almeida Fernando G., Pereira João P. and Reis Ana, Improving the environmental performance of machine-tools: influence of technology and throughput on the electrical energy consumption of a press-brake, *Journal of Cleaner Production*, 19(4), 356-364, 2011.

Barata da Rocha, Abel D. Santos, P. Teixeira, M.C. Butuc, "Analysis of plastic flow localization under strain paths changes and its coupling with finite element simulation in sheet metal forming", *Journal of Materials Processing Technology*, Vol.209, Issue 11, 2009, pp. 5097-5109.

Paulo J Tavares; Mário AP Vaz; "Single image orthogonal fringe technique for resolution enhancement of the Fourier transform fringe analysis method"; *Optics Communications* 290 (2013) 33-36 (A) (DOI: 10.1016/j.optcom.2012.10.026)

Ramos-Pollán R, Guevara-López MA, Suárez-Ortega C, Díaz-Herrero G, Franco-Valiente JM, Rubio-Del-Solar M, González-de-Posada N, Vaz MA, Loureiro J, Ramos I., Discovering Mammography-based Machine Learning Classifiers for Breast Cancer Diagnosis, *J Med Syst*. 2012 Aug; 36(4):2259-69. Epub 2011 Apr 9. (DOI: 10.1007/s10916-011-9693-2)

9.4.2 Completed PhD theses

César Miguel de Almeida Vasques; "Vibration Control of Adaptive Structures: Modeling, Simulation and Implementation of Piezoelectric and Viscoelastic Damping Technologies"; Supervisor, José Dias Rodrigues, Programa Doutoral em Eng^a Mecânica, FEUP July 2008

José Augusto de Sousa Ferreira Brandão, "Gear micropitting prediction using the Dang Van High-cycle fatigue criterion"; Supervisor, Jorge Humberto Oliveira Seabra, Programa Doutoral em Eng^a Mecânica, FEUP April 2013

Tiago Cousseau, "Film thickness and friction in grease lubricated contacts: Application to rolling bearing torque loss"; Supervisor, Jorge Humberto Oliveira Seabra, Programa Doutoral em Eng^a Mecânica, FEUP October 2013

Pedro Manuel Cardoso Teixeira, "Ductile Damage Prediction in Sheet Metal Forming Processes with Experimental Validation", Doctoral Program in Mechanical Engineering, FEUP. Supervisors: Abel D. Santos, José M.A. César de Sá and F.M. Andrade Pires, FEUP, February, 2011

Ana Rosanete Lourenço Reis, "Numerical modelling of shrinkage defects induced by the feeding flow in aluminium castings", PhD in Materials and Mechanical Engineering - Ghent University. Supervisor Barbedo Magalhães (FEUP, Portugal) and Yvan Houbaert (Gent University, Belgium), February 2008

Raul Duarte Salgueiral Campilho, "Repair of Composite and Wood Structures", supervised by M.F.S.F. de Moura, Programa Doutoral em Eng^a Mecânica FEUP, 25 June 2009

Ana Maria Azevedo Neves, "Analysis of laminated and functionally graded plates and shells by a unified formulation and radial basis functions", supervised by A. J. M. Ferreira, Programa Doutoral em Eng^a Mecânica FEUP 17 December 2012

Cristina Romão, "Compósitos de Matriz Termoplástica de Baixa Viscosidade Reforçados com Fibras Naturais de Origem Vegetal", Supervised by José Esteves and co-supervised by Celeste Pereira, Programa Doutoral em Eng^a Mecânica 18 February 2013 FEUP

André R Maia Correia, "Estudo das Tensões Exercidas Sobre Próteses Fixas em Zircónia e em Titânio - Comportamento Mecânico de Estruturas Executadas em Cad-Cam", orientadores J. C. Sampaio Fernandes, J. C. Reis Campos. M. A. P. Vaz, PhD in Dental Medicine, FMDUP July 2009

Jaime M. Monteiro "Métodos de Interferometria para Inspeção Não Destrutiva"; orientadores M. A. P. Vaz and Hernani Miguel Reis Lopes; Programa Doutoral em Eng^a Mecânica, FEUP em 31 de janeiro de 2013

9.4.3 Patents and Prototypes or other research outputs

Patente portuguesa nº 104092 para "SENSOR PORTÁTIL PARA MEDIÇÃO DE FORÇAS PLANTARES EM 3D (Compact and portable Sensor For 3D Measurement Of Plantar Forces) ", Titular: Universidade do Porto e Instituto Politécnico do Porto; Data do pedido: 09-06-2008, Data de Concessão: 16-12-2010, Limite de vigência: 09-06-2028

National Patent N^o. 106004, "Avental para compensação de deformação para quinadoras (Press brake apron with compensation of deformation) ", submitted by ADIRA, authors: Adira, João Paulo Pereira and other INEGI elements,

November 2011

A Oliveira, J Coimbra (CIIMAR), J F Silva, A T Marques (INEGI) "Hyperbaric system for the long-term study and conservation for intermediate - and deep-depth aquatic organisms", International Patent WO 2009004589 (A2), 2009/01/08

J F Silva, M Portocarrero, A T Marques 'Universal cutting device for portable trimmers', European Patent nº EP1804566 A1, 2007/07/11

J F Silva, J P Nunes, A T Marques, J C Ferreira, 'Postes estruturais em compósito de matriz termoplástica', National Patent 104301, published in Boletim da Propriedade Industria 2010/05/20

Neto Rui, Silva Pedro and Lino Jorge, Prototype of a vacuum/ controlled atmosphere vacuum chamber cold crucible levitation device for the melting and casting under contra gravity of titanium alloys, using a power unit of 100kW, high frequency 50KHz power source, 2012

Neto Rui, Silva Pedro, Reis Ana and Lino Jorge, Prototype of three different small tools more one big tool for the incremental spin forming of aluminum, steel and titanium sheets for maxillofacial custom fit prosthesis among other interesting components, 2012

Shaerography prototype for non-destructive inspection (NDI) of composites. Laser illumination (CW and pulsed) and data analysis by image processing software. Prototype LOME/INEGI-SHEAR04; 2012

Rolling bearing testing adaptor - Four-Ball machine INEGI Jorge H. O. Seabra INEGI (P) e SKF-ERC (NL). SKF, Engineering and Research Center, Niuewegein, The Netherlands May 2011

Patente Internacional: Dynamic biocompatible cage for replacing intervertebral disks of the vertebral column Número de Pedido: PPI 39086/08, Pedido de Extensão Internacional com referência PCT/PT2009/000053, Data de Depósito: 14 de Outubro de 2009, Data da Concessão: 21 de Abril de 2011 Autores: Manuel Laranjeira Gomes, Ana Mafalda Fontes Pinto dos Reis, João Manuel R. S. Tavares, Isa Teixeira Santos Países Designados: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW. African Regional Intellectual Property Org. (ARIPO) (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW). Eurasian Patent Organization (EAPO) (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM). European Patent Office (EPO) (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR). African Intellectual Property Organization (OAPI) (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG). Situação: Ativa

9.4.4 Books and book chapters of international circulation

Recent Progress in Studying the Human Foot; V. C. Pinto, M. A. Marques; Mário A. P. Vaz (DOI: 10.1007/978-94-007-4068-6_10)

Hernâni Lopes and João Ribeiro, "Structural Health Monitoring in Composite Automotive Elements". Book Chapter in the "New Advances in Vehicular Technology and Automotive Engineering", Edited by J. P. Carmo and J. E. Ribeiro. In-Tech Education and Publishing, August 2012. ISBN: 978-953-51-0698-2.

J.V. Araújo dos Santos and H. Lopes "Application of Speckle Interferometry to Damage Identification", in B.H.V. Topping, (Editor), "Computational Methods for Engineering Science", Saxe-Coburg Publications, Stirlingshire, UK, Chapter 12, pp 299-330, 2012

Alves L.M., Santana P., Fernandes N. and Martins P.A.F., Manufacturing Seamless Reservoirs by Tube Forming: Finite Element Modelling and Experimentation, in Statistical and Computational Technique in Manufacturing, Springer-Verlag, 253-280, 2012. (ISBN 978-3-642-25858-9)

M. F. S. F. de Moura, R. M. Guedes, Capítulo intitulado "Fracture: Interlaminar" (pgs 155-182) da Encyclopedia of Composites, 2nd Edition, Editors: Luigi Nicolais Assunta Borzacchiello, publisher John Wiley & Sons, Hoboken, New Jersey, 2012, ISBN (printed set): 978-0-470-12828-2, Online ISBN: 9781118097298

R. M. Guedes, M. F. S. F. de Moura, Capítulo intitulado "Matrix-controlled failure modes of polymer composites" (pgs 1610-1619) da Encyclopedia of Composites, 2nd Edition, Editors: Luigi Nicolais Assunta Borzacchiello, publisher John Wiley & Sons, Hoboken, New Jersey, 2012, ISBN (printed set): 978-0-470-12828-2, Online ISBN: 9781118097298

Vieira, A.C. "Modeling Hydrolytic Degradation of PLA Devices." In: Vincenzo Piemonte. (ed.). Polylactic Acid: Synthesis, Properties and Applications. New York: Nova Publishers, 2012, chapter 7, pp. 143-160

V Richter-Trummer, P M G P Moreira, and P M S T Castro, 'Damage Tolerance of Aircraft Panels Taking into Account Residual Stress; Structural Connections for Lightweight Metallic Structures, P M G P Moreira, L F M Silva, and P M S T Castro, Editors. 2012, Springer Berlin Heidelberg. p. 173-194

Campilho RDSG. Método de Elementos Finitos: Ferramentas para Análise Estrutural (FEM - tools for structural analysis). Publindústria: Porto, Portugal; 2012. ISBN 978-989-723-028-8

J. Reis, C. Frias, A. T. Marques, Bone mechanical stimulation with piezoelectric materials. in Natural Polymers, Biopolymers, Biomaterials, and Their Composites, Blends, and IPNs, pp.293-302, 2012

9.4.5 Conference proceedings

Proc. of "International Conference on Experimental Mechanics - ICEM 15", Ed: J F Silva Gomes, M A P Vaz, Porto 22 - 27 July, 2012; Edições INEGI, ISBN: 978-972-8826-26-0

2012 - 'Structural Connections for Lightweight Metallic Structures', by Pedro M. G. P. Moreira, Lucas Filipe Martins da Silva, Paulo M. S. T. de Castro. Advanced Structured Materials series, Springer, Volume 8, 2012, DOI: 10.1007/978-3-642-18187-0

Proceedings of the 4th International Conference on INTEGRITY, RELIABILITY & FAILURE; Funchal, 23-27 June 2013

Proceedings of CIBEM X; X Congresso Iberoamericano de Engenharia Mecânica; (Ed RN Jorge; J L Alexandre; J M R S Tavares and M A P Vaz) 4 a 7 de September, 2011, Porto, Portugal

Proceedings of the first International Conference on Mechanics of Nano, Micro and Macro Composite Structures, A. J. M. Ferreira (Editor), Politecnico di Torino, 18-20 Junho 2012

IV ECCOMAS Thematic Conference: Smart Structures and Materials SMART'09, Faculdade de Engenharia da U.PORTO, PORTO, PORTUGAL, 13-15 July 2009

Proceedings of VipIMAGE 2011 - III ECCOMAS Thematic Conference on Computational Vision and Medical Image Processing, J M R S Tavares, R Natal, JC Reis Campos, M A P Vaz, Olhão, Algarve, Portugal, 12-14 Outubro 2011

Proceedings of the 5º Congresso Nacional de Biomecânica, (Ed Renato M N Jorge, João Manuel R S Tavares, et al) Espinho, Portugal 8 e 9 de Fevereiro de 2013

Proceedings of the II Internacional Conference on Biodental Engineering, (Ed Renato N J; J C Reis Campos, J M R M S Tavares, et al) Porto, 7 and 8 december 2012

Proceedings of 6º CONGRESSO LUSO-MOÇAMBICANO DE ENGENHARIA "A Engenharia como Alavanca para o Desenvolvimento e Sustentabilidade (Engineering as a Lever for Development and Sustainability)", Maputo, 29 august to 02 september, Moçambique 2011

9.4.6 New materials, devices, products and processes

"CompoLaser: Aplicação de materiais compósitos em máquinas-ferramenta (Application of composite materials in machine tools)"; R&D Project for the company ADIRA; Principal Investigator (INEGI): Ana Reis, Budget: 105,120.00€

"PORSCHE-C: Advisory and Development Series production of a metallic component obtained by stamping thin aluminum plate for mounting components injected"; R&D Project for the company Simoldes; Principal Investigator (INEGI): Ana Reis, Budget: 17,404€

"MagnoCan_Fase2: Development of new manufacturing processes with 'electromagnetic forming' e 'die-necking'; Principal Investigator (INEGI): Ana Reis

9.4.7 Software, computer code and algorithms

PROITEC - Software for image processing of interferometric patterns. Developed at LOME / INEGI and used at Univ Sao Paulo, Center for Marine Structures, and Federal University of Amazonas, Brazil, 2010

Medical database of mammography from patients with suspected breast cancer from North Portugal (already about 1200 clinical cases). <http://bcd.inegi.up.pt/>

Software: FE-based Numerical modeling applied to metal forming processes; SW Interfaces between CAD and LCA for product/process design; 2012

9.4.8 Books, including single-authored works (including scholarly editions of oral or written texts and translations with introduction and commentary)

9.4.9 Edited special issues of journals, with substantial research input on the part of the researcher

9.4.10 Chapters in books, including contributions to conference proceedings, essays in collections

9.4.11 Creative writing (to the extent that it embodies research)

9.4.12 Encyclopedia entries (to the extent that they embody research)

9.4.13 Audio/visual and electronic/digital materials

9.4.14 Other categories, including web-based resources; video and audio recordings (to the extent that they embody research)

9.4.15 Performances and exhibitions to the extent that they embody research

9.4.16 Other research outputs

Workshop Internacional "The Dang Van Fatigue Criterion"; Faculdade de Engenharia da Universidade do Porto, 27 de Outubro de 2008

Workshop Nacional, "Engrenagens de Elevado Rendimento"; ISEP-IPP, Porto, Portugal, 16 de Dezembro de 2010

Workshop Nacional, "Redução de custos na manutenção com a ajuda da Tribologia", Porto, Portugal, 16 de Novembro de 2012

Desenvolvimento de Produto, Prototipagem e Maquetagem", Chairman: Jorge Lino, organization of INEGI, Ordem dos Engenheiros Região Norte and FEUP, INEGI, Porto, 22 Junho 2009

F. Jorge Lino, "Tecnologias de Fundição, Prototipagem Rápida e Conformação Plástica" Workshop INEGI I&D 2010, INEGI, 17 de Março de 2010

9.4.17 Organisation of scientific dissemination activities

15th International Conference on Experimental Mechanics - ICEM 15, Porto 22 - 27 July, 2012

CIBEM 10, X Congresso Ibero-Americano em Engenharia Mecânica, Porto, Portugal, 4 a 7 de setembro 2011

A. J. M. Ferreira, Chair of ICCS15-15th International Conference on Composite Structures, FEUP, 15-17 June 2009

A.J.M. Ferreira, Co-chair of 1st International Conference on Mechanics of Nano, Micro and Macro Composite Structures, Torino, 18-20 June 2012

Integrity - Reliability - Failure, IRF´ 2009, que decorreu no Porto de 20 a 24 Julho de 2009

International Conference VII Iberian Conference on Tribology - IBERTRIB 2013, Faculty of Engineering, University of Porto, Portugal, 20-21 June 2013

Workshop Internacional; Rolling Contact Fatigue Meeting - RCF 2010, FEUP, Porto, Portugal, 19-20 de Julho de 2010

CompIMAGE'2012 Symposium - Computational Modeling of Objects Represented in Images: Fundamentals, J M R S Tavares, Paolo Di Giamberardino, R Natal, Methods and Applications, Rome, Italy, September 5-7, 2012

VipIMAGE 2011 - III ECCOMAS Thematic Conference on Computational Vision and Medical Image Processing, J M R S Tavares, R Natal, JC Reis Campos, M A P Vaz, Real Marina Hotel & Spa, Olhão, Algarve, Portugal, 12-14 Outubro 2011

Mini-Simpósio "Processamento de Imagem e Visualização" inserida no Congresso de Métodos Numéricos em Engenharia - CMNE 2011, (J M R S Tavares, Xavier Roca, Universidad Autónoma de Barcelona), Coimbra, Portugal, 14-17 Junho 2011

9.4.18 Research contracts with national or international entities

LIFE - Project LIFE aimed at developing a Portuguese supply chain for business jet cabin interiors including engineering, design, materials, and R&D. The main project outcome was a new cabin-fuselage concept, which considered the effects of an isogrid-like structure in the cabin design and a real size (7m long) cabin demonstrator. This project became the centre piece of the Portuguese participation in LeBourget in 2012 and earned a significant international prize: the Crystal Cabin Award.

PAIC - The Portuguese Aeronautical Industry Consortium (PAIC) is a recently concluded project where 14 different institutions worked on achieving an industrial unmanned aeronautical vehicle (UAV) product. This project, where INEGI had a leading role in coordination activities, production and integration, developed two aircraft (30kg and 80kg MTOW), as well as entire systems packages

XAeroStructures - this follow-on project from PAIC aims at taking the PAIC's second aircraft concept to a 250kg MTOW, while looking fundamentally at creating a basis for the creation of an industrial component certification activity in Portugal

NewFace - project with Embraer Portugal, NewFace aims at looking at new aircraft fuselage concepts for products to be launched by the manufacturer in 2030

BOJO - Increase of Bolted Joint Performance, ESA TRP Study, Project in collaboration with DLR, High Performance Space Structures and Systems (HPS), Kyser-Threde, MT-Technology, EADS-CASA Espacio, Contraves, SABCA. The goal of this project was to develop advanced hybrid composite laminates to increase the efficiency of highly loaded CFRP bolted joints

NACO - ESA GSTP Study in collaboration with HPS (DE), FutureCarbon (DE), ARC Seibersdorf (AT), PIEP (P), INEGI (PT), University of Patras (GR) and Electrovac (AT). The main objective of this project was to develop and characterize carbon nanotube (CNT) based nanocomposites, by infiltrating nanotube skeletons with either an organic or inorganic matrix. Nano modified composite materials, especially CNT reinforced composite materials offer a high potential for successful applications in space. Some potential uses of these materials could be in manufacturing light-weight structures, laser transmitters and their components or even as part of laser diodes, with the purpose of acting as heat sinks

"COMPINTEGRA" - Development of an integrated process of casting, brazing, machining and balancing of compressor wheels made of aluminum, steel and titanium alloys". Project QREN CO-Promotion between Zollern and Comandita Portugal (ZCP) and INEGI. Founding Agency: ADI - Innovation Agency. Principal Investigator (INEGI): Rui Jorge de Lemos Neto. Budget: Total value of 1.800.000 €, with 1.200.000€ for INEGI.

"Coquirot - Development of a tilt chill vacuum-assisted processes for casting aluminum alloys"; Founding Agency: QREN Empresas Individuais STA, Society of Manufacturing Aluminum. INEGI is a subcontractor. Principal Investigator (INEGI): Rui Jorge de Lemos Neto. Others researchers: Ana Rosanete Reis, António Barbedo de Magalhães, Ricardo Paiva, Bárto Paiva, Armada Marques, Nuno Azevedo and Fernando Moreira. Budget: 260.000€

"Britacolor - Development of a painting process for decorative granite gravel"

"AEROVAC - Development of an investment casting process to produce nickel super alloys heat shields for combustion chambers of turbo reactors".

9.4.19 Projects funded in national and international competitive calls

MAXBE - Interoperable monitoring, diagnosis and maintenance strategies for axle bearings. FEUP Jorge H. O. Seabra e Luís Andrade Ferreira European Union 339 000.00€ November 2012 to Outubro 2015

XGEAR - Development of Gear Drive-Trains based on new Materials and Novel Gear Systems D'Appolonia, Bologna, Italy Jorge H. O. Seabra and Ramiro Martins European Union, GROWTH Programme, Proposal 030433, Contrato COLL-CT-2006- 030433. 66 432,00€ September 2006 to February 2010

Low Power Loss Gears Luís M. L. Magalhães e Jorge H. O. Seabra INEGI FCT - PTDC/EME-PME/73389/2006; 120 000,00€; January 2007 to December 2010

COMTICAST - Development of a titanium casting process for turbo compressor wheels", April 2008 to August 2010 at INEGI and ZCP, QREN CO-Promotion between Zollern and Comandita Portugal (ZCP) and INEGI, Agência de Inovação ADI, 1.200.000 € with 900.000€ for INEGI, responsible for the project at INEGI: Rui Jorge de Lemos Neto

TOOLING EDGE - Development of new competences inside the mould making Portuguese Industry, "Engineering and Tooling" for the health and aerospace sectors, namely custom fit prosthesis, composite and hybrid aeronautic structures. Founding Agency: QREN- Projectos Mobilizadores, funded by Innovation Agency; Principal Investigator (INEGI): Rui Jorge de Lemos Neto and Nuno Correia.; Partners: 20 Portuguese Mould making companies: i.e. Iberomoldes, Distrim 2, Distrim 2 New Concept, M.P.Tooling, L N Moldes, and 6 Portuguese Research Institutes i.e. Centimfe, IST, U. Minho, IPN and IPL; Budget: 600,000 € for INEGI; Period: November 2010 - November 2013

Multi-scale modeling of Hexagonal Closed Pack (HCP) materials with spring-back prediction Multi-scale modeling of Hexagonal Closed Pack (HCP) materials with spring-back prediction, PTDC/EME-TME/105688/2008; Funding Agency: FCT; Partners: UA - Universidade de Aveiro (proponente), IDMEC - Instituto de Engenharia Mecânica, INEGI/UP - Instituto de Engenharia Mecânica e Gestão Industrial; Principal Investigator (INEGI): Abel Santos; Total Budget (€): 139.724,00€, INEGI: 42.404,00€; Period: April 2010 - March 2013

New Technological Solutions for Smart Cardiovascular Medical Devices - EDAM-SenseCardioHealth;(J M R S Tavares) Funding: Fundação para a Ciência e a Tecnologia, Concurso para Projetos de Investigação Científica e de Desenvolvimento Tecnológico no âmbito do Programa MIT|Portugal 2008 (ref. UMIT-Pt/EDAM-EMD/0007/2008), 285.732,00 Euros (2 years)

"A new generation of biodegradable implants obtained from magnesium alloys functionalized by means of advanced surface treatment" Partners: Instituto Superior Técnico da Universidade de Lisboa (Instituição proponent); Faculdade de Medicina Dentária da Universidade do Porto; The Institute of Precision Mechanics of the Faculty of Materials Science & Engineering, Warsaw University of Technology (Polónia); Materials Engineers Group of the Faculty of Materials Science & Engineering, Warsaw University of Technology (Polónia). Funding: European Micro and Nano Technology Network, 7º Programa Quadro (FP7) - ERA-MNT/0002/2009

"Desarrollo y explotación de Sistemas para Diagnóstico Asistido de Cáncer de Mama" Client: Faculdade de Medicina - Departamento de Radiologia Hospital São João FMUP-HSJ). Partners: Centro Extremeño de Tecnologías Avanzadas (CETA), CIEMAT, España, Faculdade de Medicina - Departamento de Radiologia Hospital São João. Funding: Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT), España

Wafer design Approach for Safety Increasing in worst case Situations minimizing joints (WASIS) (<http://www.wasis.eu/>)

9.5. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE RESEARCH GROUP 2015/2020

9.5.1 Structure of the Research Group

The Experimental Mechanics New Materials and manufacturing research group for the period 2015/2020 is expected to be formed by

64 PhD members being 20 from the faculty of Engineering, 20 from INEGI, 6 from the faculty of dental medicine 5 members from the faculty of Medicine and the other from faculties of ISEP-IPP, IPB, and ESEIG.

This group seeks through the completion of multidisciplinary projects to develop new solutions in the structural behavior of materials area, damage identification and estimation of residual life, maintenance, wear mechanisms and clinical applications of materials for functional and esthetic rehabilitation.

Mario Vaz (associate professor of the department of mechanical engineering (DEMec) of FEUP) will head the group and simultaneously coordinate the research activities in experimental mechanics and Biomechanics.

Jorge Seabra (full professor DEMec and president of INEGI) will coordinate the research activities in tribology vibration and industrial maintenance.

Jorge Lino (associate professor DEMec) will coordinate the research activities in advanced materials and new production technologies. He is also responsible for study Biomedical applications of new mechanical solutions to reestablished mobility and esthetics, prosthesis implants and orthotics.

Marcelo Moura (associate professor DEMec) will coordinate the research activities in the composites group. He is also responsible for the development of new numerical models for damage simulation and live perdition in composites and live tissues

9.5.2 Objectives of the Research Group

New technics for NDI, structural monitoring and integrity assessment in aircraft structures. Optimization and characterization of emerging joining technologies. Structural monitoring systems for wind generators. Intelligent mechanical joints for online damage detection, Hybrid numerical/experimental techniques for SIF determination in crack propagation. Software for Image processing in optical metrology. Image processing for clinical diagnosis. 3D Shape characterization using structured illumination. Biomechanics to study the human movement in contexts like rehabilitation, clinic (Orofacial and orthopaedics), sports and occupational. Study of human performance in harsh environments for civil and military application. Engineering applied to sports

Tribology of grapheme-based coatings. Friction and wear in prosthetic elements. Modeling/testing of grease lubricated rolling/sliding contacts: Starvation, friction, wear, tribofilms, grease aging and graphene nano-particles. Modeling/testing of micropitting and wear in gears and rolling bearings, using mixed film lubrication and multi-axial fatigue criteria.

Modeling/testing the influence of gear tooth design and lubricant formulation on gearbox power loss. Testing the piston ring - cylinder liner contact.

Modelling/testing of passive damping treatments for vibration and sound radiation control, using feasible FE based tools and efficient damping configurations applied to real objects; Hybrid numerical-experimental dynamic methodologies: identification of mechanical properties of resilient materials which depend on frequency and temperature; Vibration based strategies for condition monitoring of machines. Development of design strategies to include the tribological data in the reliability analysis; Development of new maintenance strategies.

Processing of advanced metal-based alloys: Melting and pouring in vacuum/controlled atmospheres of Ti-aluminides, Ti-alloys and other alloys (Invar, Ni, Mg, and Co-Cr) and their machining. Ceramic shell design and manufacture. Metal foam, metal additive manufacturing and metal matrix composites.

Methodology for custom fit prosthesis and body-shape products: For soft and hard tissues, via manipulation of medical images. Involves data exchange between several Clinical Imagiology, CAE supported Product Development and CNC machining SW apps, till an Additive Manufacturing prototype model (usually wax) and conversion into a cast metal part, among others.

New manufacturing processes for advanced materials: Key technologies to be explored for industrial enabling: electromagnetic forming/welding; incremental sheet forming and Laser microprocessing. Includes energy source-material interaction, process&tooling and support's equipment development.

Composite Materials research group intends to increase its scientific activity namely in some specific areas as is the case of thermoplastic matrix composite manufacturing, rheology and thermo-gravimetric analysis of composites and polymers, dynamic behavior and repair of composite structures, nano-composites and mechanical and fracture characterization of composite biomaterials. It is envisaged that the composites group can be strengthened in these and other already established areas, in order to increase the already existing national participation in European and International agenda and programs as well as serve as a tool for the deepening of the Portuguese industry's participation in these forums.

10. PROPOSED THEMATIC LINES

Reference	Name	Principal Investigator
TL-50022-1395	Energy	Eduardo Guimaraes de Oliveira Fernandes

TL-50022-1396	Transports Technology	Jorge Alberto Cadete Ambrosio
TL-50022-1397	Aeronautics and Space	Afzal Suleman
TL-50022-1398	Key Enable Technologies	José Carlos Fernandes Pereira
TL-50022-1399	Future and Emerging Technologies	José Carlos Fernandes Pereira

(TL-50022-1395) Energy

10.1. IDENTIFICATION OF THE THEMATIC LINE

10.1.1 Reference of Thematic Line

TL-50022-1395

10.1.2 Name of the Thematic Line in Portuguese

Energia

10.1.3 Name of the Thematic Line in english

Energy

10.1.4 Principal Investigator

Eduardo Guimaraes de Oliveira Fernandes

10.1.5

Scientific areas

Mechanical Engineering and Engineering Systems

10.2. DESCRIPTION OF THE THEMATIC LINE

10.2.1 Description of the Thematic Line

Energy is a broad R&D topic that, on the one side, engages many branches of Science and, on the other side, is called upon to respond to a wide spectrum of environmental, technological, economical and societal challenges. That implies that energy permeates all human activity and life and therefore cannot be seen strictly as a commodity as has been suggested and promoted by the 'oil culture' of the last one hundred years.

The main umbrella for energy in the 21st Century is definitely 'global sustainability' understood mainly as the reduction of the production of greenhouse gases, mainly CO₂, through energy shifts at the primary and vector levels and through technology advances including the so called energy efficiency. This, bearing in mind the fact that over 1.5 billion people still do not have access to most of the amenities provided by the currently marketed energy systems.

The LAETA's Energy Line involves 40 researchers with a PhD degree plus 40 PhD students and 40 other collaborators. It is now the proper time for the LAETA's energy line to stimulate the emergence of a dynamics of cooperation in the energy field seen from the perspective of Mechanical Engineering as expressed in the selection of the following sub-topics:

- i) Energy efficiency (in buildings, in cities, in industry),
- ii) Low cost, clean energy supply (renewables, clean combustion),
- iii) Energy storage (hydrogen and fuel cells, integrated systems),
- iv) Energy planning and market uptaking (dissemination and capacity building, energy planning).

This listing may not appear as clear cut as, for instance, 'energy efficiency' or 'clean energy supply' that are both strongly technology dependent, the same applying also to the other topics. Yet this list responds to some coverage of the field already in place at the existing LAETA research groups and tries to respond from a dominantly Mechanical Engineering perspective to the rationale of the EU 'Horizon 2020' Program.

The importance of the basic research cannot be overemphasized. The basic research will focus on modelling issues of fluid flow, heat and reactive flows and the engineering research will be devoted to systems of great complexity. This latter contributes to improving scale facilities and scientific infrastructures in close cooperation with national and international partners. It is still necessary to incorporate the use of existing technologies in novel applications by means of the continuous improvement of energy efficiency in industries.

Currently the common areas to, at least, two of the research groups in the energy line of LAETA include energy efficiency in buildings and industry, renewables, including biofuels, and clean combustion, hydrogen and fuel cells and energy planning. Those topics with their extension and subdivisions may not offer immediate opportunities for a common program in R&D. So some effort will be needed to be proposed and eventually supported by Portuguese institutions besides the subsidiary opportunities offered by the EU R&D Horizon 2020.

That does not prevent from highlighting in this proposal some opportunities and formulate some topics that already have in the context of this LAETA Program the participation of, at least, three research groups in the energy line. The formulations will be still quite open but the commitment that will be expressed here in such a direction will represent a major asset of this proposal in the energy field for Portugal, that has some specificities in relation to the EU as a whole.

10.3. RESEARCH GROUPS INVOLVED IN THE THEMATIC LINE

Reference	Name
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RG-50022-1619	Intelligent Systems
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RG-50022-1624	Renewable and Sustainable Energy Systems
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RG-50022-1625	Engineering Design, Automation and Energy
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RG-50022-1627	Energy, Environment and Comfort
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10.4. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE THEMATIC LINE

10.4.1 Structure of the Thematic Line

Scientific Board: the scientific board is composed of the line coordinator and the Directors of all Groups that participate in its activities. The Scientific Board is in charge of proposing and promoting the research activities of the line in addition to preparing the submission of joint projects and organizing dissemination activities.

Besides management meetings, a one day workshop will be promoted on a yearly basis in order to present the activities of the line, foster intra- and inter-tasks collaboration and to promote involvement in external projects, with those projects launched within the framework of Horizon 2020 being of particular interest.

The line coordinator is also responsible for preparing the yearly plans, reports and evaluations. Finally, the line coordinator is also responsible for organising the activities of the line in such a way that activities undertaken correspond to the programme drawn up by the Scientific Board. The line coordinator should promote the involvement of all resources available at LAETA in order to carry out the research programme and promote interaction between research lines.

10.4.2 Objectives of the Thematic Line

In this context, without excluding the potential for cooperation agreements in other specific topics among the research groups, it seems that there is potential for interaction and definition of coordinated integrated projects in the four main areas as follows.

i) Energy efficiency

Buildings - There is some tradition in these topics at the research groups 2, 5 and 7 with some accomplishments both in the country and at the EU level. The same happens with research group 8 specifically in comfort issues. It seems feasible to undertake some common projects. An important research proposal will be on the holistic approach of the energy and indoor environment issue in the building stock bearing in mind the climate and the challenges of energy efficiency together with the intensification of the use of the renewable of proximity, active and passive;

Industry - In the last two decades research groups 2, 5, 7 and 8 have established very strong connections with the Portuguese and European industry through direct projects and EU funded projects. Currently, all research groups have competences not only in the quantification of the energy saving potential in different industrial sectors but also in the identification and evaluation of opportunities for optimization, which is crucial for improvements in competitiveness. Against this background common projects will be developed in the following specific areas: heat recovery, process and combustion efficiency, alternative fuels and novel cleaning methods.

ii) Low cost, clean energy supply

Renewable - This is another area where research groups 2, 5, 7 and 8 have research competencies and skills to develop together innovative projects. Specifically, in the period 2015-2010, the efforts of the research groups will be directed towards the (a) development and promotion of new and renewable energy technologies, including wave energy, not only in the EU but also in developing countries and remote regions, and (b) development of alternative, renewable fuels and chemicals from biomass, including microalgae, to reduce fossil fuel dependence and preserve the environment, via processes such as flash pyrolysis.

Biofuels - This is always a polemic energy vector which has received as an R&D topic some interest at research groups 2, 5 and 8. The interest is reaffirmed, not forgetting the extensive experience that these laboratories have on combustion, including biofuels burning processes.

iii) Energy storage

Hydrogen and fuel cells - Currently, research group 5 integrates a consortium in an EU funded project (NEMESIS 2+), whose main objective is to develop a small-scale, fuel flexible hydrogen generation prototype system capable of

producing 50 Nm³/h H₂ from diesel and biodiesel. This project is reinforcing LAETA competences in this area and the research groups of the energy line intend to establish a program to reduce hydrogen production costs and increase the reliability and efficiency of H₂ based systems.

iv) Energy planning and market uptaking

Cities - An important research proposal will be on the energy planning and management for sustainable cities, the latter acting as proxies for the population's most common uses of energy: at home and in their mobility.

Market & Social - It is widely reckoned that consumer 'education' barely 'pays' in particular in what regards energy use, commonly said 'consumption'. However, through planning approaches and community involvement it is expectable that the efficiency on the use of energy can be successfully reached. That has been the experience with a family of projects in EU such as Concerto and, more recently, the city focused Covenant of Mayors. Partners of LAETA's energy line believe that here there is an adequate field to undertake studies that will lead to both: guarantee of convergence with the climate change targets (global sustainability) and adjustment of the energy uses to the exergy of the available resources.

(TL-50022-1396) Transports Technology

10.1. IDENTIFICATION OF THE THEMATIC LINE

10.1.1 Reference of Thematic Line

TL-50022-1396

10.1.2 Name of the Thematic Line in Portuguese

Tecnologia de Transportes

10.1.3 Name of the Thematic Line in english

Transports Technology

10.1.4 Principal Investigator

Jorge Alberto Cadete Ambrosio

10.1.5

Scientific areas

Mechanical Engineering and Engineering Systems

10.2. DESCRIPTION OF THE THEMATIC LINE

10.2.1 Description of the Thematic Line

This section includes three tasks that correspond both to national requirements and to the objectives of Horizon 2020 for Smart, Green and Integrated Transports and more particularly 'Mobility for Growth', 'Green Vehicles' and 'Small Business and Fast Track Innovation for Transport'. The three tasks are:

Greener vehicles addresses energy related topics in the spheres of Transports, Railway and Road vehicle dynamics; Logistics, including Intelligent Transport Systems; and, Safety and security (in which Passive and Active safety and Thermal and Acoustic Comfort are addressed). In the framework of LAETA, the research groups seek to develop synergies to advance the State-of-Art. This provides frameworks for developing enabling technologies which, in turn, facilitate the expected emergence of future technologies in the area of transports while maintaining the support for current technologies.

Task 1: Greener Vehicles

Energy in Transports: The research and development undertaken in this topic rank high in National and European priorities for the next decade. This task addresses the quest for alternative fuels and powertrains, the lifecycle of fuels and vehicles for transport use, the implementation of sustainable development mechanisms in transportation, ambient modelling and monitoring of vehicles, traffic emission modelling, development and application of information and communication for urban mobility, development of simulators for ecological driving and the quantification of the urban access indicators. The work proposed includes the implementation of a laboratory for the real-time integrated

motorization of passenger vehicles with conventional fuels, hybrid or electric powertrains in which it is possible to collect the polluting emission components, to infer the indicators for safety and comfort of the vehicle and the biometric signs of the occupants.

Railway Dynamics: support for new railway vehicle technologies requires research into advanced wheel-rail contact models, pantograph-catenary interaction and infrastructure modelling accounting for flexibility. Issues such as wear and contact fatigue in the rail-wheel interface and vehicle track compatibility play key roles in the development of railway technologies. Fatigue behaviour prediction of stir welded joints for vehicle structures and the development of new concepts for the body in white constitute innovative research topics to be addressed. This involves both the development at the National and European level of compatible vehicle systems to improve trans-frontier mobility and the enhancement of future technologies for high-speed trains

Road Vehicle Dynamics: The development of novel modelling techniques for automobiles and motorcycles - entailing the use of new materials and advanced numerical procedures - requires research into advanced tire models, compliant kinematic joints for enhanced suspension systems, structural flexibility of vehicle components and control of driving systems for vehicle-human enhanced interfacing. Issues such as human comfort to vibrations are better addressed in the framework of this task. On the one hand, the development of new construction techniques includes the optimization of weight and flexural characteristics, innovative adhesive bonded joints, thermo-electrical-mechanical manufacturing processes, tube forming and joining or sheet forming of metals and polymers. The development of these new techniques involves new materials - among which composites play a major role - and alternative energy sources. These correspond to the requirements of the European Green Car Initiative but nevertheless require an upgrade and a revision of many classic areas in road vehicle dynamics in order to address anticipated technological needs.

Task 2: Logistics

Intelligent Transportation Systems: One of the well-established objectives of the European agenda concerns research and innovation with regard to equipment and systems for smarter, more automated, cleaner and quieter vehicles. Research and innovation concerning smart infrastructure solutions is necessary in the deployment of innovative traffic management and information systems, advanced traveller services, efficient logistics, construction and maintenance technologies. This task addresses the intelligent optimization of logistic systems, optimization of transportation chains, distributed control based on cooperative behaviour in transports, development of the next generation of transport means using intelligent control systems, developing cleaner propulsion technologies based on electric batteries and comfort design methodologies. These enabling technologies will serve as a basis for the development of future technologies such as truck platooning in highways, intelligent traffic control or advanced interfacing between transportation modes.

Task 3. Safety and Security

Railway and Road Vehicle Dynamics: support for active safety in transports requires research and developments in the field of vehicular dynamics. This has been described in Task1 and, consequently, is not repeated here.

Passive Safety of Occupants: the continuing improvement of the protection of passengers and goods in different modes of transportation involves two sub-areas: structural crashworthiness and injury biomechanics. The use of new materials, mainly composites, alternative energy sources and their storage, and the continued effort to introduce greener railway transportation entails revisiting and bringing traditional protection strategies up to date. In this context, the development of smarter vehicle interiors and a better understanding of the crashworthy behaviour of materials subjected to high rate loading are of utmost importance. The development of better performing sensors and actuators and research into new integration strategies give this area a very high potential for technological development and transfer to industry. At the same time, the improvement of current modelling and analysis strategies in accident reconstruction provides added value for society at large.

Thermal and Acoustic comfort: Thermal and acoustic comfort rank high in terms of the development of strategies for long. In terms of interior environmental comfort, passenger compartments of vehicles are a demanding environment with regard to comfort conditions. The cabin should also be designed in such a way as to take into account an extremely wide range of outdoor weather conditions as this supposes limitations in fuel/energy economy. Besides human vibration comfort, this task addresses discomfort stressors such as thermal environment, indoor air quality, noise and ergonomics. The combined effects of discomfort stressors, using real road tests, test benches or computer simulation, are investigated. The data of objective measured values will be integrated in evaluation indices, which are then correlated with data collected on subjective perception on the part of users.

10.3. RESEARCH GROUPS INVOLVED IN THE THEMATIC LINE

Reference	Name
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RG-50022-1619	Intelligent Systems
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RG-50022-1620	Manufacturing and Industrial Management
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RG-50022-1622	Mechanical Design
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RG-50022-1624	Renewable and Sustainable Energy Systems
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RG-50022-1625 Engineering Design, Automation and Energy

RG-50022-1627 Energy, Environment and Comfort

RG-50022-2178 Experimental Mechanics New Materials and Manufacturing

10.4. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE THEMATIC LINE

10.4.1 Structure of the Thematic Line

Scientific Board: the scientific board is composed of the line coordinator and the Directors of all Groups that participate in its activities. The Scientific Board is in charge of proposing and promoting the research activities of the Line in addition to preparing the submission of joint projects and organizing dissemination activities.

Besides management meetings, a one day workshop will be promoted on a yearly basis in order to present the activities of the line, foster intra- and inter-tasks collaboration and to promote involvement in external projects, with those projects launched within the framework of Horizon 2020 being of particular interest.

The Line coordinator is also charged with preparing the Yearly plans, reports and evaluations. Finally, the Line coordinator is also responsible for organising the activities of the Line in such a way that activities undertaken correspond to the programme drawn up by the Scientific Board. The Line coordinator should promote the involvement of all resources available at LAETA in order to carry out the research programme and promote interaction between research lines.

10.4.2 Objectives of the Thematic Line

The thematic strand for transports comprises three major areas, all of which are in line with the objectives of ("the European" is not necessary unless there is a non-European H2020) Horizon 2020 for Smart, Green and Integrated Transports addressing the topics included in 'Mobility for Growth', 'Green Vehicles' and 'Small Business and Fast Track Innovation for Transport'. The contribution to the European goal of eliminating fossil fuels from urban transportation and seriously limiting them in other modes of transportation is one of these objectives.

The objectives, by and large, are to: develop, test and implement technologies that promote sustainable transportation; evaluate and compare alternative technologies and fuels within the transportation industry; study innovative solutions in urban logistics in order to enhance city sustainability and, finally, to promote safer and more comfortable vehicles that allow transport alternatives with ambient and ecological gains.

Whilst contributing to these global objectives, more specific goals include (but are not limited to):

Implementation of a laboratory for the real-time integrated monitorization of passenger vehicles.

Development of traffic emission modelling procedures and simulators for ecological driving.

Evaluation and comparison of alternative technologies and fuels within the transport industry to allow for the achievement of European goals for cleaner and greener transportation.

Advanced contact models for the wheel-rail interface applicable to the framework used for compatibility, wear and fatigue.

Development and implementation of new materials, including composites, for greener, lighter and safer road and railway vehicles.

Development of new concepts for buses using composite materials and meeting stringent crashworthiness and flexural requirements.

Development of advanced modelling and simulation procedures for road and railway vehicles that include advanced tire contact models, structural flexibility of the system components and joint compliance.

Novel optimal vehicle construction techniques for minimal weight and optimum flexural characteristics using stir welding, tube and sheet forming and new adhesive bonded joints.

Development of smart infrastructures enabling innovative traffic management so as to address traveller services, efficient logistics and green and economical maintenance technologies.

Optimization of transportation chains including the control of cooperative behaviour in the field of transports and platooning.

Development of new passive safety technologies that recognize the application of new materials and powertrain concepts in vehicle technologies in order to improve structural crashworthiness and human injury protection.

To develop novel solutions for vehicle interiors in order to enhance thermal and noise comfort by means of innovative designs and the application of new materials.

(TL-50022-1397) Aeronautics and Space

10.1. IDENTIFICATION OF THE THEMATIC LINE

10.1.1 Reference of Thematic Line

10.1.2 Name of the Thematic Line in Portuguese

Aeronáutica e Espaço

10.1.3 Name of the Thematic Line in english

Aeronautics and Space

10.1.4 Principal Investigator

Afzal Suleman

10.1.5

Scientific areas

Mechanical Engineering and Engineering Systems

10.2. DESCRIPTION OF THE THEMATIC LINE

10.2.1 Description of the Thematic Line

Aeronautics and Space are entering a new age - the age of sustainable growth - characterised by the need for more affordable, cleaner, quieter, safer air travel and space exploration. New research and development will be essential in responding to this challenge. The research work programme seeks to meet the goals of strengthening and integrating national and European research initiatives and society's needs for more efficient, safer and environmentally friendly air travel and space exploration.

The Thematic Line in Aeronautics and Space primarily involves the following groups: Aerospace Science and Technology, Mechanical Design, Renewable and Sustainable Energy, all at IDMEC/UL; Engineering Design, Automation and Energy at INEGI/UP; and Aeronautics and Astronautics at AEROG/UBI.

Research into Air Vehicles is focused on the following areas: multifunctional and adaptive composite structures, aircraft design, aeroacoustics, aeroelasticity, active aeroelastic control, Flight Dynamics, Stability and Control: Air Traffic Management, damage and fracture mechanics, structural health monitoring, multidisciplinary design optimization, and UAVs. Research into Fluid Dynamics involves the following areas: turbulence physics and modelling, multiscale and multiphysics, new computational paradigms and CFD, and experimental fluid mechanics. Research into Space includes developments in orbital mechanics, interplanetary missions and space probes.

a) Structures and Materials: The increased use of composite and smart materials and structures in the next generation of aircraft and spacecraft depends on the in-depth knowledge of the mechanical behaviour of these materials. Deficiencies in knowledge concerning material response and the absence of appropriate models representing the mechanical behaviour of advanced composites have a negative effect on the recurring and non-recurring cost of composite structures used in spacecraft. The non-recurring costs are currently too high due to the requirement of experimentally validating a composite structure at all stages of product development (building-block approach).

b) Damage and Fracture Mechanics: Due to the high level of specific stiffness of advanced composite materials, composite structures are very often strength critical, rather than stiffness critical as is usually the case in metallic structures. Therefore, the design of composite structures must take into account the onset and propagation of the different damage mechanisms occurring in a composite material. Furthermore, damage tolerance analysis must be performed during the service life of a composite structure. Taking into account the complexity of the onset and interaction of the damage mechanisms occurring in advanced composites (e.g. matrix cracks, fiber fracture), structural integrity analyses of composite materials needs to be performed using a combination of Continuum Damage Mechanics and Fracture Mechanics. Also application of friction stir welding in aeronautical structures need to be investigated.

c) Aerodynamics, Turbulence and Computational Fluid Dynamics: CFD has impact on a very wide range of Technologies such as high-lift and drag reduction, efficient engines, noise and vibration, smart structures etc. Today, the simulation of the full aircraft is possible with the Reynolds averaged form of Navier-Stokes equations but the accuracy with regard to drag prediction is still unsatisfactory. Final verification with wind tunnel experiments is still required due to the unsatisfactory prediction of the effects of turbulence in most of the simulations.

d) Aeroacoustics: The increase in air travel requires reduced noise per flight. At approach to land with the engine at idle aerodynamic noise can be dominant; thus it is necessary to reduce both engine and airframe noise. Noise reductions of 10-20 dB are likely to be the limit of evolutionary technologies, and radical solutions like new aircraft configurations may

be needed beyond 20 dB. Besides external noise cabin noise, should also be considered.

e) Instrumentation and Flight Testing: any evolution in the aeronautical field has been made possible by the development of more powerful instrumentation systems, allowing for parameter measurement and its usage in a large variety of applications, (i.e. guidance and control, process monitoring, data visualisation, flight testing).

f) Multidisciplinary Design Optimization: the design and development of aerospace systems and structures is probably one of the more challenging design areas, and it represents the area where a great effort has been devoted to the development of MDO as an effective design tool. This requires complex analysis in different fields, this means that the development of MDO methodologies for the design of aerospace structures and systems constitute a crucial step towards further, successful development.

g) Turbulence Physics and modelling of research work has been directed towards analysing the physics of the turbulent/nonturbulent interface and role of vortices near the edge of free shear layers. The results show that different LES models lead to variations in the Reynolds stresses near the jet edge, something that will affect mixing rates near turbulent/non-turbulent interfaces.

h) Multiphysics/Multiscale and Uncertainty Quantification: the main objective is to develop mathematical and computational tools to study uncertainty issues in reactive flows, hemodynamic flows and forest fire propagation, using both intrusive and non-intrusive techniques.

i) New computational Paradigms and CFD: the goal is to improve the GPU computing structure able to deal with complex fluid flow problems including hybrid parallel strategies. Aerothermodynamics of hypersonic flight including atmospheric re-entry, space environment and solar-terrestrial physics; stellar astrophysics and cosmology.

j) Experimental Fluid Mechanics (DPIV, LDA, and PDA), experimental and numerical studies will be carried out with reference to instability and transition and micro-aerial-vehicles, Vertical/short take-off and landing (V/STOL) aircraft and spray characteristics.

l) Astrodynamics and Space Science: atmospheric re-entry, solar-terrestrial physics, astrophysics and cosmology and analytic and numerical studies of several aspects of orbital mechanics and space mission design

m) Air Traffic Management: The growth of air traffic at 5% per year needs doubling of capacity every 15 years putting serious challenges on runway capacity at airports and en-route traffic. Safety must be maintained while increasing capacity while avoiding ground delays, in flight holding patterns and indirect routes that waste fuel and increase emission. Research on reduced safe separation en-route and at take-off and landing is essential to allow further growth of timely air transport.

10.3. RESEARCH GROUPS INVOLVED IN THE THEMATIC LINE

Reference	Name
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RG-50022-1571	Aerospace Science and Technology
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RG-50022-1619	Intelligent Systems
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RG-50022-1620	Manufacturing and Industrial Management
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RG-50022-1622	Mechanical Design
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RG-50022-1624	Renewable and Sustainable Energy Systems
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RG-50022-1625	Engineering Design, Automation and Energy
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RG-50022-1627	Energy, Environment and Comfort
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RG-50022-1630	Aeronautics and Astronautics
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RG-50022-2178	Experimental Mechanics New Materials and Manufacturing
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10.4. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE THEMATIC LINE

10.4.1 Structure of the Thematic Line

Scientific Board: the scientific board is composed of the line coordinator and the Directors of all Groups that participate in its activities. The Scientific Board is in charge of proposing and promoting the research activities of the Line in addition to preparing the submission of joint projects and organizing dissemination activities.

Besides management meetings, a one day workshop will be promoted on a yearly basis in order to present the activities of the line, foster intra- and inter-tasks collaboration and to promote involvement in external projects, with those projects launched within the framework of Horizon 2020 being of particular interest.

The Line coordinator is also responsible for preparing the yearly plans, reports and evaluations. Finally, the Line

coordinator is also responsible for organising the activities of the Line in such a way that activities undertaken correspond to the programme drawn up by the Scientific Board. The Line coordinator should promote the involvement of all resources available at LAETA in order to carry out the research programme and promote interaction between research lines.

10.4.2 Objectives of the Thematic Line

The proposed research and development programme focuses on applied air and space vehicle technologies, including systems and components.

The work programme is structured in four areas of research that, amongst other objectives, will contribute to achieving the

objectives of strengthening competitiveness of national industries in the European and global market, mitigating environmental impact with regard to emissions and noise, improving vehicle safety and security and increasing the operational envelope.

The work programme covers the spectrum of research and technology development from basic research to technology validation. The emphasis will be placed on open upstream research to further improve the technology base and develop innovative concepts and breakthrough technologies to pave the way for improvements in air and space vehicles. The research domains may include integrated design and product development, manufacturing, maintenance, aerodynamics, structures, propulsion, guidance, navigation and control, and new aircraft and space vehicle concepts (unmanned air vehicles, morphing aircraft, inflatable space structures and planetary probes, to name but a few). Additionally, efforts will be focused on downstream research integrating a critical mass of technical fields. The research projects will normally encompass the integration of technologies across a number of topics and will include their validation in laboratory test beds and simulations.

The research program in Aeronautics aims to improve the performance of complex engineering systems through advances in mathematical and computational models, and experimental methods that incorporate multidisciplinary analysis and design optimization for the synthesis of optimal designs. The primary objective is to connect emerging mathematical models and enabling technologies with new designs and concepts of operation to achieve "Leaner, Greener and Safer" Transportation, with the main emphasis being on aerospace systems.

The long term objectives of the proposed programme are to gain improved understanding, and to characterize and model complex engineering systems at the boundaries of current knowledge and relevant to a wide range of applications; to develop multidisciplinary, functional and reliable computational models with broad predictive and design optimization capabilities; and to apply knowledge and computational tools in order to generate sustainable and improved designs for the next generation of aerospace transportation systems. The processes of interest relate to the interactions of complex flows with nonlinear aerostructures, the design and integration of actuators and sensors in multifunctional composite materials and structures, and systems integration for experimental verification and evaluation of the proposed solutions.

To this end, the short term objectives of the programme have been planned along two streams: (i) development of mathematical models and tools related to core disciplines in fluids (computational fluid dynamics with traditional mesh dependent methods and meshless methods such as smoothed particle hydrodynamics), structures (linear and nonlinear finite element methods and new Lagrangian meshless methods such as peridynamics), and their interaction dynamics in the context of a multidisciplinary design analysis and optimization framework; new analytic solutions for special problems in space mission design; simplified thermal modelling of spacecraft; and (ii) application of these tools and processes to emerging aerospace technologies: Lean and green aircraft: from fluttering wings to morphing flight; safe aircraft: structural health monitoring and life prognosis of aircraft composite structures; and unmanned air vehicles; thermal effects on spacecraft in deep space missions; new solutions for spacecraft trajectories in space missions to small objects of the solar system.

(TL-50022-1398) Key Enable Technologies

10.1. IDENTIFICATION OF THE THEMATIC LINE

10.1.1 Reference of Thematic Line

TL-50022-1398

10.1.2 Name of the Thematic Line in Portuguese

Tecnologias Facilitadoras Essenciais

10.1.3 Name of the Thematic Line in english

Key Enable Technologies

10.1.4 Principal Investigator

José Carlos Fernandes Pereira

10.1.5

Scientific areas

Mechanical Engineering and Engineering Systems

10.2. DESCRIPTION OF THE THEMATIC LINE

10.2.1 Description of the Thematic Line

The development programme focuses on the recommendations and policies that are central to a timetable that extends to the year 2020. The European Union's 2020 Strategy seeks to promote smart, sustainable and inclusive growth and the choices made by LAETA, in terms of content, have been made with direct reference to EU Strategy. LAETA has identified its own strengths and has striven to ensure that resources are combined in such a way as to create new knowledge, expertise and business activities.

Given its mission and human capital, LAETA is particularly well placed to meet the objectives of Horizon 2020. These objectives will be oriented around three priorities: excellent science, industrial leadership, and societal challenges. The areas of expertise at LAETA include computational and experimental mechanics, materials and their mechanical behaviour, optimization, tribology, vibrations, and multibody dynamics and manufacturing. All these areas will play a role in addressing the three priorities in an integrated way. Concurrently, deep upstream research - science - will be required so as to ensure pertinent contributions to societal needs through more applied R&D based on up to date, novel results.

The importance of the area of Key-Enable Technologies to the overall aims and objectives of LAETA is crucial and involves the most significant, multidisciplinary association of research groups ever proposed in Portugal. The integration of a wide ranging and diverse set of research groups and facilities into a broad, single body serves the twofold implementation objective of, firstly, providing know-how to the other areas of LAETA in topics where the researchers of these areas are usually not involved and, secondly, of fostering the transformation of ideas into value added, saleable, advanced engineering solutions and products by bringing together researchers with different but complementary skills and competences.

In particular, the area of Key-Enable Technologies will be responsible for developing the products and processes involved in manufacturing the prototypes and the low batch series that are required to promote and transfer the ideas and technologies to be developed in the aforementioned areas of Energy, Transports and Aeronautics.

All the research groups are involved in the area of Key-Enable Technologies in order to ensure the link with the areas of Energy, Transports and Aeronautics but there are six groups that have their activities centred in this area as a result of their transversal role in LAETA. These groups are: Intelligent Systems, Manufacturing and Industrial Management, Mechanical Design, Experimental Mechanics and New Materials, Engineering Design, Automation and Energy, and Forest Fires and Detonics.

The aims and objectives of the groups are comprehensively described in Section 9 and the description of the thematic line in Key-Enable Technologies is built upon the following six thematic strands that emerge from the aforementioned six groups and are transversal to LAETA.

Advanced Manufacturing, Prof. P. Martins

The thematic strand in advanced manufacturing is centred on the development of new manufacturing processes, on the application of existing manufacturing processes to new materials and on the identification of new levels of understanding for manufacturing processes by means of theoretical and experimental methods and procedures.

Advanced Materials, Prof. A. Ferreira

The thematic strand in advanced materials is focused in applications of new metallic, non-metallic and composites materials, of nano-materials for improving mechanical, thermal, fire, among other properties and in the utilization of new materials for biological/biomedical applications for tissue repair, reconstructions and devices.

Biomechanics, Prof. H. Rodrigues

The thematic strand on biomechanics is focused on mechanobiology and tissue biomechanics, human movement biomechanics, cardio-vascular blood simulation in vitro under physiological conditions, computer assisted surgery and biomechatronics devices and prosthesis and orthopaedics.

Engineering Design, Prof. P. Tavares de Castro

The thematic strand on engineering design is focused on computational and experimental mechanics, materials and their mechanical behaviour, multidisciplinary optimal design methodologies for the concurrent and eco-design, tribology, vibrations and multibody dynamics.

Engineering Systems, Prof. J. C. Sousa

The thematic strand in engineering systems is focused on design of mechatronics systems, automation and intelligent data-based modelling for control and optimization of complex engineering problems.

Fires, Prof. D. Xavier Viegas

The thematic strand in Fires is focused on combustion processes including explosions under non controlled conditions in the natural environment (e.g. Forest fires) in buildings and in industrial facilities. The emphasis in forest fires results from the Central Region of Portugal's development programme that includes environment and citizen protection as a priority.

10.3. RESEARCH GROUPS INVOLVED IN THE THEMATIC LINE

Reference	Name
RG-50022-1619	Intelligent Systems
RG-50022-1620	Manufacturing and Industrial Management
RG-50022-1622	Mechanical Design
RG-50022-1625	Engineering Design, Automation and Energy
RG-50022-1628	Forest Fires and Detonics
RG-50022-2178	Experimental Mechanics New Materials and Manufacturing

10.4. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE THEMATIC LINE

10.4.1 Structure of the Thematic Line

The thematic Line on Key Enable Technologies has two managing Boards:

Coordination Board: the coordination board is composed of the LAETA Coordinator and the Leaders of each Strand. The LAETA scientific Coordinator may delegate the coordination of the Key Enable Technology Line to one of the Leaders of the Thematic strand.

Scientific Board: the scientific board is composed of all members of the Coordination Board alongside the Directors of all Groups that participate in its activities.

The Scientific Board is responsible for proposing and promoting the research activities of the Line as well as for preparing the submission of joint projects and organizing dissemination activities. The Coordination Board is in charge of organizing the activities of the Line according to the programme proposed by the Scientific Board.

Besides the management meetings, a one day workshop will be promoted in a Yearly basis to present the activities of the line, foster collaborations intra and inter tasks and to promote involvement in external projects, namely those launched in the framework of Horizon 2020

10.4.2 Objectives of the Thematic Line

The research line in Key Enable technologies aims to provide engineering know-how to Energy, Transport Technologies and Aeronautics and Space in topics not directly covered by the researchers working in these areas and to carry out fundamental and applied state-of-the-art research in the main thematic strands of Advanced Manufacturing, Advanced Materials, Biomechanics, Engineering Design, Engineering Systems and Fires. The first objective is necessary to implement the overall aims and objectives of LAETA of transforming scientific knowledge and technologies developed in the areas of Energy, Transport and Aeronautics into useful and saleable products and processes. The second objective results from a vision that securing such engineering capabilities while contributing to invert the decline of national economic and social health requires an effective innovative and multidisciplinary approach to project, design, manufacturing and industrial management.

Under these circumstances the research line in Key-Enable Technologies is introduced as the summation of the individual objectives of the following six thematic strands:

Advanced Manufacturing

Mechanical and Thermal Processing of Materials-mechanical behaviour of materials, forming, machining, casting, welding and joining, micro-manufacturing, machine-tools and tooling systems

Polymer, Ceramic and Composite Material Processing -forming and shaping of polymers, ceramics and composites, rapid-prototyping, machine-tools and tooling systems.

Lean, Agile and Life Cycle Approaches to Manufacturing-material and process selection, life-cycle assessment and sustainable manufacturing, costs and management of complex design processes.

Advanced Materials

Medical Applications- biomaterials, new polymers and composites, long-term material properties, human soft tissues and bone scaffolds.

Composites-new laminates, new nano-materials and hybrid materials. Multi-scale modelling and applications to passive and active solutions for vibration and sound control

Adhesives-self-healing cohesive formulations, new computational techniques for fracture mechanics and doped adhesives by addition of cork particles

Tribology-micro and nano lubricants for friction improvement in traditional applications and medical prosthesis

Biomechanics

Mechanobiology and Tissue Biomechanics- models to study bio-tissue adaption processes, design of prostheses and bone scaffolds for clinical applications, study of pelvic tissues mechanical properties to understand physiologic mechanisms.

Human movement biomechanics-biomechanical models for dynamic gait analysis, design of orthotic devices to support locomotion and clinical decision.

Computer assisted surgery and biomechatronics devices-systemic, biomimetic methods and algorithms for hybrid human-machine systems, human-robot interaction technologies with applications in medical robotics and exoskeletons.

Engineering Design

Multidisciplinary optimal design methodologies for the concurrent and eco design of mechanical component/structures and materials

Non-linear dynamics, multi-body dynamics and their applications to railway engineering

Design for manufacturing, taking into account economic and environmental constraints

Design methodologies for lightweight structures and for using natural/renewable materials such as natural fibers or biodegradable polymers

Engineering Systems

Mechatronic Systems - integrated design of mechatronic systems, hybrid human-machine systems, fleets of robotic vehicles in ground, aerial and marine scenarios

Automation and Systems Integration for energy, transports and aeronautics

Intelligent data-based modelling- data analysis in prediction and decision making. Distributed control and optimization.

Fault tolerant control in networked systems, transports and energy.

Fires

Environment protection (forest and urban fires) and personnel safety

Utilization of explosive generated shock waves for high-energy-rate processing and synthesis of materials

(TL-50022-1399) Future and Emerging Technologies

10.1. IDENTIFICATION OF THE THEMATIC LINE

10.1.1 Reference of Thematic Line

TL-50022-1399

10.1.2 Name of the Thematic Line in Portuguese

Tecnologias Futuras Emergentes

10.1.3 Name of the Thematic Line in english

Future and Emerging Technologies

10.1.4 Principal Investigator

José Carlos Fernandes Pereira

10.1.5

Scientific areas

Mechanical Engineering and Engineering Systems

10.2. DESCRIPTION OF THE THEMATIC LINE

10.2.1 Description of the Thematic Line

The Future and Emerging Technology line, FET, is the fifth and last LAETA line of the present proposal. In the previous four LAETA thematic lines (energy, transport technologies, aeronautic and space and key enable technologies) many development measures were outlined relating to current strengths of the outlined research topics. However LAETA

has 253 PhD integrated members and there are other choices, promising, embryonic knowledge sectors that are still small in terms of their critical mass, but whose competitive advantages should be identified.

Future emerging technologies, FET, is the thematic line where new ideas, technologies and operating practices must be piloted in a broadminded way, and choices must be made in an uncertain environment. The research line mission is to promote high-risk research. Experimentation and risks are part of all research as well as innovation and other creative activities, however the main difference of FET to the previous four thematic lines is about the less incremental nature of the research. The research proposed must find its plausibility in new ideas and concepts, rather than in the application or incremental refinement of existing ones.

The research must address a new, original or radical long-term vision of technology-enabled possibilities that are far beyond the state of the art. The research must target scientifically ambitious and technologically concrete breakthroughs. The FET research line gives a threefold contribution:

- Firstly FET explores promising visionary ideas that can contribute to challenges of long-term importance and helping them mature in emerging research communities.
- Secondly FET fosters novel non-conventional approaches and foundational research in selected themes in response to emerging societal and industrial needs. Among them the Healthy Living and Active Ageing offers a large spectrum of opportunities of innovation in which some of the researchers will be focused. Improving lifestyle management, fostering active and independent living in an age-friendly environment are sectors where mechanical engineering and systems and materials may be of great relevance.
- Thirdly, the FET requires intensive co-operation between excellent, multidisciplinary and multi-sector teams with participants from all sectors of the knowledge triangle (higher education, research and innovation). Consequently the FET thematic line promotes the opening of LAETA to the world and particularly to other research fields such as Mathematics, Informatics, Medicine, Material Science etc.

There are others emerging societal and industrial needs that have been previously addressed. For example Urban Mobility was one of the topics of the Transport Technologies. Urban mobility addresses a number of topics such as transport (including new mobility concepts, transport systems safety and security), environmental issues (reduction of greenhouse gases, air pollution and noise). However apart from those incremental scientific contributions the area of sustainable urban mobility can only be achieved if breakthrough innovations leading to greener, more inclusive, safer and smarter solutions are found. The open doors to this high-risk research is located and stimulated in FED. Other topic previously addressed in an incremental stairway approach was the emerging industrial need of industrialization. According to the European Innovation Agenda one of the sectors where the problem is particularly urgent is manufacturing.

10.3. RESEARCH GROUPS INVOLVED IN THE THEMATIC LINE

Reference	Name
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RG-50022-1571	Aerospace Science and Technology
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RG-50022-1619	Intelligent Systems
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RG-50022-1620	Manufacturing and Industrial Management
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RG-50022-1622	Mechanical Design
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RG-50022-1624	Renewable and Sustainable Energy Systems
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RG-50022-1625	Engineering Design, Automation and Energy
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RG-50022-1627	Energy, Environment and Comfort
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RG-50022-1628	Forest Fires and Detonics
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RG-50022-1630	Aeronautics and Astronautics
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RG-50022-2178	Experimental Mechanics New Materials and Manufacturing
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10.4. ORGANISATIONAL STRUCTURE AND OBJECTIVES OF THE THEMATIC LINE

10.4.1 Structure of the Thematic Line

Scientific Board: the scientific board is composed of the line coordinator and the Directors of all Groups that participate in its activities. The Scientific Board is in charge of proposing and promoting the research activities of the Line in addition to preparing the submission of joint projects and organizing dissemination activities.

Besides management meetings, a one day workshop will be promoted on a Yearly basis in order to present the activities of the line, foster intra- and inter-tasks collaboration and to promote involvement in external projects, with those projects launched within the framework of Horizon 2020 being of particular interest.

10.4.2 Objectives of the Thematic Line

The future emerging technologies objectives highlight promising visionary ideas that can contribute to challenges of long-term importance. The objective of the R&D basic research on Future and Emerging Technologies in Energy, Transports and Aeronautics and Space is to promote new ideas and support early stage, highly interdisciplinary research approaches and to explore visionary ideas that can contribute to challenges of long-term importance with respect to:

- Aeronautical morphing technologies
- Novel aircraft configurations

Like flying wing, V-tail, shielded and buried engines, for high-efficiency and low emissions in cruise flight and low noise at take-off and landing.

- New trends and methods in computational engineering
- Non-equilibrium turbulence
- Living fluids turbulence

New ideas are necessary about the multistage dynamics and inner multiscale geometry and topography of the turbulence. In particular, fractal grids led to the discovery of a hitherto unknown non-equilibrium turbulence regime with very unusual but well-defined dissipation properties. These new dissipation properties have led to current studies of interscale transfers and vorticity-strain dynamics in spatially developing turbulent flows and a re-examination of the classical Kolmogorov (1941) equilibrium theory of turbulence.

Simple forms of life, like amoebae or bacteria, self-organize into remarkable macroscopic patterns, ranging from extended networks to complex vortices and swarms. A particularly interesting manifestation of collective behavior in microbial suspensions is the emergence of meso-scale turbulent motion. Driven by the microorganisms' self-propulsion and their mutual interactions, such self-sustained "active turbulence" can have profound effects on nutrient mixing and molecular transport in microbiological systems.

- Ambient Assisted Living-ICT for Ageing
- Systems Engineering in the Life Sciences

The rise of genomics and accumulation of heterogeneous amounts of biological and biomedical data is driving the emergence of a new systems-based approach to life sciences. The foremost question in Systems Biology and Medicine is how to explain the complexity of living organisms by integrating multiscale data from physiological experiments.

Systems Engineering and Control are playing a central role in unraveling this structure and understanding the behavior of complex organisms, with direct applications to interpreting physiological systems through a mathematical and computational perspective.

Health issues now represent a great socio-economical burden. It is expected that research aimed at improving therapy regimes will have great impact on health policies, namely by predicting disease progression and quantitatively assessing risk factors in a personalized context. The development of a clinical decision support system for optimizing therapy allocation constitutes a valuable outcome of this line of research, supporting the development of Translation Research, while strengthening the advance on methods in Engineering Systems. In the scope of future proposals in Horizon 2020, personalized medicine is widely recognized as a key field in Healthcare, in which Engineering Systems will play a major role.

11. BUDGET FOR THE STRATEGIC PROGRAMME 2015/2020

11.1 The unit is a candidate for evaluation and intend to apply for funding?

Yes

11.2

Host institution's budget

Instituto de Engenharia Mecânica (IDMEC)

Description	2015	2016	2017	2018	2019	2020	TOTAL (€)
Human Resources	390000	420000	450000	480000	510000	546000	2796000

Missions	120000	120000	120000	120000	120000	120000	720000
Consultants	5000	5000	5000	5000	5000	5000	30000
Service Procurement and Acquisitions	120000	120000	120000	120000	120000	120000	720000
Patent Registration	5000	5000	5000	5000	5000	5000	30000
Adaptation of Buildings and Facilities	20000	20000	20000	20000	20000	20000	120000
Overheads	176000	183000	190000	197000	204000	211000	1161000
Equipment	221000	226000	231000	237000	242000	241000	1398000
TOTAL (€)	1057000	1099000	1141000	1184000	1226000	1268000	6975000

Other institution's budget

Associação para o Desenvolvimento da Aerodinâmica Industrial (ADAI)

Description	2015	2016	2017	2018	2019	2020	TOTAL (€)
Human Resources	126440	131498	136758	142228	147917	153834	838675
Missions	13080	13603	14147	14713	15302	15914	86759
Consultants	0	0	0	0	0	0	0
Service Procurement and Acquisitions	32700	34008	35368	36783	38254	39784	216897
Patent Registration	0	0	0	0	0	0	0
Adaptation of Buildings and Facilities	2180	2267	2358	2452	2550	2652	14459
Overheads	36000	37000	39000	40000	42000	43000	237000
Equipment	7600	7624	7369	7824	5977	5816	42210
TOTAL (€)	218000	226000	235000	244000	252000	261000	1436000

Universidade da Beira Interior (UBI)

Description	2015	2016	2017	2018	2019	2020	TOTAL (€)
Human Resources	29000	30500	31416	32916	33600	35100	192532
Missions	8060	8060	8508	8508	9000	9000	51136
Consultants	500	500	528	528	550	550	3156
Service Procurement and Acquisitions	7500	7500	7916	7916	8000	8000	46832
Patent Registration	350	350	369	369	400	400	2238
Adaptation of Buildings and Facilities	750	750	800	800	850	850	4800
Overheads	13000	13000	14000	14000	15000	15000	84000
Equipment	19840	21340	21463	22963	24600	26100	136306
TOTAL (€)	79000	82000	85000	88000	92000	95000	521000

Instituto de Engenharia Mecânica e Gestão Industrial (INEGI/UP)

Description	2015	2016	2017	2018	2019	2020	TOTAL (€)
Human Resources	688000	712000	735000	758000	782000	801000	4476000
Missions	115000	120000	125000	130000	135000	141000	766000
Consultants	6500	7000	7500	8000	8500	8500	46000
Service Procurement and Acquisitions	86000	90000	94000	98000	102000	107000	577000
Patent Registration	1600	1700	1800	1900	2000	2500	11500
Adaptation of Buildings and Facilities	8000	9000	10000	11000	12000	15500	65500

Overheads	191000	198833	206500	214000	221667	229333	1261333
Equipment	49900	54467	59200	63100	66833	71167	364667
TOTAL (€)	1146000	1193000	1239000	1284000	1330000	1376000	7568000

Overall budget

Description	2015	2016	2017	2018	2019	2020	TOTAL (€)
Human Resources	1233440	1293998	1353174	1413144	1473517	1535934	8303207
Missions	256140	261663	267655	273221	279302	285914	1623895
Consultants	12000	12500	13028	13528	14050	14050	79156
Service Procurement and Acquisitions	246200	251508	257284	262699	268254	274784	1560729
Patent Registration	6950	7050	7169	7269	7400	7900	43738
Adaptation of Buildings and Facilities	30930	32017	33158	34252	35400	39002	204759
Overheads	416000	431833	449500	465000	482667	498333	2743333
Equipment	298340	309431	319032	330887	339410	344083	1941183
TOTAL (€)	2500000	2600000	2700000	2800000	2900000	3000000	16500000

12. STRATEGIC PROGRAMME AND BUDGET RATIONALE 2015/2020

12.1 Overall budget rationale

The strategic program and budget rationale of LAETA is built upon the aim and objective of leveraging the overall R&D performance of the institution to international levels of excellence in the field of mechanical engineering. The budget rationale represents approximately 20% of the total amount of funding that is currently needed to carry out the ongoing R&D activities of LAETA and is focused in the following three goals:

1. Setup the new generation of researchers of LAETA by attracting young engineers and doctors with very high potential;
2. Maintain the experimental and computational infrastructure, upgrade equipment to control the hidden costs of obsolescence and reinforce the human resources at the laboratorial level in order to cope with the intensive experimental activity of LAETA;
3. Increase the capability of LAETA to promote R&D projects at both National and European levels, to engage in innovation and technology transfer projects funded by companies, and to offer training programs in innovative technologies.

The vision behind the renovation of the research staff is of primary importance because the Portuguese Universities have not been recruiting academic staff in the past 10 years and because the amount of post-doctoral research grants is nowadays almost inexistent. The generational gap resulting from this policy requires a minimum number of 25 (2015) to 35 (2020) PhD. research assistants to be hired during the next five years. Some of these researchers will end up as leading professional engineers in companies and others will become the next generation of Portuguese academics in mechanical engineering.

Since LAETA is empowered by a significant and intense network of laboratories it is necessary to hire at least 12 laboratory technicians (with MSc. or PhD degrees). This is a major recommendation from the international Advisory Council of LAETA. The budget for 'Human Resources' is the consequence of what was said above.

The strategy related to equipment is not transversal to the entire units of LAETA. Research groups from IDMEC that are located in Lisbon have been out of funding to upgrade their experimental and computational infrastructure for more than 10 years due to governmental, European and regional policies. In contrast, other research groups like those from INEGI were recently (2011-2013) able to perform significant investments (above 2.0 M€) on new equipment. Moreover, these days, when budgets are shrinking and cost control is at the top of the agenda setting and decision making, it is important to understand the hidden costs of maintaining obsolescence and to recognize how reliability, lower maintenance, improved safety and numerous other intangibles can be obtained by replacing obsolete equipment. From what was mentioned above it is easy to understand that almost 75% of the budget for 'Equipment' is devoted to the upgrade and modernization of the laboratory infrastructure of IDMEC. This strategy results from a recommendation of the Advisory Council.

The budget for 'Service procurement and acquisitions' derives from LAETA being strongly anchored in experimental and computational R&D. In general, 50% of the costs are related to maintenance of equipment and the other 50% are

related to consumables.

The strategy to increase the capability of promoting research and industrial funding projects is focused on networking with leading international research centers. Participation in major international conferences is the first vector of this strategy. The second vector is directed towards promotion and support of visiting scholarships with the purpose of strengthening the integration of researchers in international thematic communities, increasing the visibility of LAETA's research activities near the key players of international research project proposals and acquiring knowledge in state-of-the-art technologies. The budget for 'Missions' is less than 30% of the total expected requirements to fulfil the aforementioned objectives and the remaining 70% will come directly from other funding sources such as projects. The budget for 'Consultants' will be utilized to cover the travel and expenses of the members of the Advisory Council during their annual visits to Portugal and to invite international researchers to give invited lecturers in emerging research topics.

The small amount of funding that is requested for 'Adaptation of Buildings and Facilities' will be mainly utilized for modifications and repairs that will be necessary for installing new equipment in the laboratories.

To conclude it is worth mentioning that a recent report by FCT indicates LAETA as the Portuguese research institution with the highest ratio (6.36) of non-FCT funding (39.2 M€) to the FCT strategic funding (6.2 M€) during 2007-2011. The report also indicates that LAETA was ranked 3rd among the Portuguese research institution participating in FP7 European projects (25) and ranked 8th in attracting FP7 funding (5.21 M€).

12.2 Human Resources rationale

The human resources rational results from the strategic program, the overall budget rationale and the recommendations of the Advisory Council of LAETA that were previously described in Section 12. Breakdown per institution is the following:

IDMEC:

Contracts and Scholarships for researchers with PhD - 11 per year - 340 k€ (funded at 30% by other projects)

Contracts for 3 laboratory technicians with MSc./PhD. - 50 k€ (funded at 30% by other projects)

The increase planned from 2015 to 2020 is 1 Ph.D. Researcher Assistant per year and 1 Laboratory Technician every two years.

Total Human Resources IDMEC - 2796 K€.

5 contracts and scholarships for researchers with PhD and 3 contracts for laboratory technicians are currently supported by the present LAETA's strategic budget. Other contracts and scholarships for researchers with MSc. and PhD will be sponsored from other funding sources (e.g. projects).

INEGI:

Scholarships for researchers with MSc - 18.75 per year - 1504.1 k€

Scholarships for researchers with PhD - 7.5 per year - 807.3 k€

Contracts with laboratory technicians - 5.0 per year - 614.0 k€ (funded at 75%).

Contracts with auxiliary researchers (PhD) - 6.0 per year - 1404.0 k€ (funded at 75%).

Total Human Resources INEGI - 4476 K€.

Six PhD's, with high quality CV's, will be contract and funded at 75%. They will be responsible for projects funded by National and European funds and projects involving technology transfer to industrial companies. These projects will fund part (25%) of their contracts.

Laboratory technicians will also be involved in projects funded by National and European funds and projects involving technology transfer to industrial companies. These projects will fund part (25%) of their contracts.

ADAI:

The required budget for human resources comprises 2 post-doc scholarships and 2 auxiliary researcher contracts (during limited periods of time), and 2 laboratory technicians in full time.

Total Human Resources ADAI - 838.7 K€.

The overall budget of ADAI has a strong component in human resources to support the existing experimental and computational capacities that are main assets of ADAI and are used in the research program.

AEROG:

The required budget comprises 1 contract with auxiliary researchers

Total Human Resources AER - 192.5 k€

12.3 Equipment rationale

The equipment rational of LAETA is mainly targeted to upgrade the laboratory of IDMEC and follows a major recommendation of the Advisory Council. The breakdown of the equipment rational to purchase during 2015-20 throughout the IDMEC labs is the following

Aeronautics

Laser sheet flow measurement for wind tunnel 80k€
Upgrade acoustic measurement and signal processing 20k€
Upgrade flight simulator 10 k€
Equipment for flight test and space simulation 10k€

Combustion

Chemical characterization of solid fuels 18k€
CMOS camera and microscope 29k€
Capillary rheometer 50k€
Portable atmospheric aerosols analyzer 10k€
Gas analyzers 45k€
Digital infrared cameras 33k€
Variable drive/generator 22k€
Video camera 13k€
Transient measurement system 20k€

Manufacturing

Shearing machine 20k€
Data acquisition system 30k€
3D system for strain analysis 50k€
CNC hydraulic press 50k€
CNC machining center 50k€
Optical system forming analysis 50k€
Roughness tester 10k€
Hardness tester 10k€
Optical microscope 30k€

Experimental mechanics

Vibration analyser/shakers 35k€

Composite

Furnace 78k€
Autoclave 80k€
Air cleaning system 10k€
Lay up tables 5k€

Biomechanics

Treadmill 10k€
Dynamometer 22k€
3D Motion Track System 15k€
3 D Scanner 11k€
High Speed Camera 7k€

Mechatronics

Robotic platforms 100k€
Optical navigation 60k€
Ultrasound probes 50k€
Smart materials 50k€

Computational

Computer Hardware 85k€
Small high performance PC Cluster 30k€
Software licenses 90k€

IDMEC's investment in equipment is 8.5% of LAETA's budget. The remaining budget for equipment will be distributed as follows:

INEGI

Recently made a significant investment (>2.0M€) on new equipment, so that equipment is limited to 5.5% of the overall budget

ADAI

To update computer hardware and to buy new instruments and commonly used equipment for the laboratories

AEROG

To purchase 1 data acquisition system and 1 green laser for LDV, several load cells to the wind tunnel, components for

UAVs, computer hardware and software

13. REVIEWERS PROPOSED BY THE R&D UNIT(S)

13.1

Name	Institution	Email	Scientific Areas
Prof. Dimosthenis Trimis	Karlsruher Institut für Technologie - Germany	trimis@kit.edu	Mechanical Engineering and Engineering Systems
Prof. Werner Schiehlen	Technical University Stuttgart - Germany	werner.schiehlen@itm.uni-stuttgart.de	Mechanical Engineering and Engineering Systems
Prof. Michel Geradin	University of Liege - Belgium	mgeradin@gmail.com	Mechanical Engineering and Engineering Systems