



**IN+**

**Center for Innovation, Technology and Policy Research**  
*Centro de Estudos em Inovação, Tecnologia e Políticas de Desenvolvimento*

# Annual Report 2001

Available at <http://in3.dem.ist.utl.pt>

Instituto Superior Técnico, Lisboa  
March 2002



**Center for Innovation, Technology and Policy Research**

Centro de Estudos em Inovação, Tecnologia e Políticas de Desenvolvimento

## **Annual Report: 2001**

### **Contents**

#### **I. Research Team**

#### **II. Mission and Results**

1. Mission and Organization
2. Research Team Experience
3. Research Topics and Results: Knowledge creation
  - 3.1 Laboratory of Thermofluids, Combustion and Energy Systems
  - 3.2 Laboratory of Environmental Systems
  - 3.3 Laboratory of Technology Policy and Management of Technology
4. Beyond Research: Knowledge Transfer and Diffusion
  - 4.1 Advanced Training – Main Post-Graduation Education Programmes
  - 4.2 Advanced Training – Workshops
  - 4.3 Main R&D Projects
  - 4.4 C&T commercialisation activities
  - 4.5 International Conference Series
  - 4.6 Main Editorial Activities

#### **Annexes:**

- A1: Indicators
- A2: List of publications
- A3: Individual CV's of doctorate researchers

## I. RESEARCH TEAM (as by January, 2002)

### Investigadores doutorados Integrados

Nome completo	Grau académico	Categoria profissional	% tempo elegível	Fracção
<a href="#">Manuel Frederico Tojal Valsassina Heitor</a>	AGREGAÇÃO	PROFESSOR CATEDRÁTICO	75%	1
<a href="#">Dimantino Freitas Gomes Durão</a>	AGREGAÇÃO	PROFESSOR CATEDRÁTICO	10%	
<a href="#">Antonio Luis Nobre Moreira</a>	DOUTORAMENTO	PROFESSOR AUXILIAR	50%	1
<a href="#">Edgar Caetano Fernandes</a>	DOUTORAMENTO	PROFESSOR AUXILIAR	70%	1
<a href="#">Gabriel Paulo Alcantara Pita</a>	DOUTORAMENTO	PROFESSOR AUXILIAR	40%	1
<a href="#">João Miquel Pires Ventura</a>	DOUTORAMENTO	PROFESSOR AUXILIAR	40%	1
<a href="#">José Miquel Mendes Lopes</a>	DOUTORAMENTO	PROFESSOR AUXILIAR	40%	1
<a href="#">Mario Nery Rodrigues Nina</a>	DOUTORAMENTO	PROFESSOR ASSOCIADO	30%	1
<a href="#">Paulo Manuel Cadete Ferrão</a>	DOUTORAMENTO	PROFESSOR ASSOCIADO	70%	1
<a href="#">Pedro Filipe Teixeira Conceição</a>	DOUTORAMENTO	PROFESSOR AUXILIAR	60%	1
<a href="#">Rui Baptista</a>	DOUTORAMENTO	PROFESSOR ASSOCIADO	60%	1

### Bolseiros doutorados

Nome completo	Grau académico	Categoria profissional	% tempo elegível	Fracção
<a href="#">Vayalakkara Sivadas</a>	DOUTORAMENTO	INVESTIGADOR PRINCIPAL	100%	1
<a href="#">Armando Azevedo Caldeira Pires</a>	DOUTORAMENTO	INVESTIGADOR PRINCIPAL	100%	1
<a href="#">Nuno Arantes-Oliveira</a>	DOUTORAMENTO	INVESTIGADOR PRINCIPAL	60%	1
<a href="#">Serguei Ivanovich Chtork</a>	DOUTORAMENTO	INVESTIGADOR PRINCIPAL	100%	1

### Alunos/Investigadores

Filipe Manuel Simões Santos - [fmsantos@dem.ist.utl.pt](mailto:fmsantos@dem.ist.utl.pt)  
Aldina Maria Pedro Soares - [asoares@est.ips.pt](mailto:asoares@est.ips.pt)  
José Amaral - [jamaral@dem.ist.utl.pt](mailto:jamaral@dem.ist.utl.pt)  
Paulo Jorge Santos Monteiro Anacleto - [anacleto@dem.ist.utl.pt](mailto:anacleto@dem.ist.utl.pt)  
Pedro Manuel Sousa Mendes Oliveira - [oliveira@unc.edu](mailto:oliveira@unc.edu)  
Pedro Ferreira - [pmf@rpcp.mit.edu](mailto:pmf@rpcp.mit.edu)  
Paula Meireles - [paulam@dem.ist.utl.pt](mailto:paulam@dem.ist.utl.pt)  
Jorge Olívio Penicela Nhambiu - [nhambiu@dem.ist.utl.pt](mailto:nhambiu@dem.ist.utl.pt)  
Pedro Cabral Santiago Faria - [pedrofaria@yahoo.com](mailto:pedrofaria@yahoo.com)  
Robert Edward Leandro - [robert.leandro@dem.ist.utl.pt](mailto:robert.leandro@dem.ist.utl.pt)  
Paulo Henrique Figueiredo Vaz - [pvaz@netcabo.pt](mailto:pvaz@netcabo.pt)  
Francesco Mosca - [fra.mosca@dem.ist.utl.pt](mailto:fra.mosca@dem.ist.utl.pt)  
Casimiro Eduardo da Conceição Cala - [cala@dem.ist.utl.pt](mailto:cala@dem.ist.utl.pt)  
Nuno Manuel Rolo Creado - [nrolo@dem.ist.utl.pt](mailto:nrolo@dem.ist.utl.pt)  
Ana Moita - [anamoita@dem.ist.utl.pt](mailto:anamoita@dem.ist.utl.pt)  
Ângela Canas - [angelac@dem.ist.utl.pt](mailto:angelac@dem.ist.utl.pt)  
Paulo Jorge Trigo Ribeiro - [pribeiro@dem.ist.utl.pt](mailto:pribeiro@dem.ist.utl.pt)  
Paulo Gil dos Santos Silva - [psilva@dem.ist.utl.pt](mailto:psilva@dem.ist.utl.pt)

Ana Paula Pires - anapaulapires@iol.pt  
Anabela de Jesus Adriano Piedade - anabelapiedade@dem.ist.utl.pt  
Carla Maria do Rosário Costa - carla.r.costa@netcabo.pt  
Eugénia Maria Bengalinha Ramiro - eramiro@dem.ist.utl.pt  
João Veríssimo Meyer - joaomeyer@hotmail.com  
Óscar David Carvalho da Silva Ferreira  
Rita Maria de Ceia Hasse Ferreira - rhferreira@hotmail.com  
Manuel João Rocha Pereira - mjb@dem.ist.utl.pt  
Miguel Rosa Panão - mpanao@dem.ist.utl.pt  
Hugo Duarte Alves Horta - hugo.horta@dem.ist.utl.pt  
Miguel Martinho Lopes Praça - mpraca@dem.ist.utl.pt  
Nuno José Pereira Ávila Martins - navila\_martins@hotmail.com  
Patrícia Isabel Alves Gomes Lages - plages@dem.ist.utl.pt  
Pedro Queiroga Ramos Nazareth - pedronazareth@dem.ist.utl.pt  
Nuno Miguel Faria Cegonho - nunocegonho@iol.pt  
Sérgio Manuel Ferreira de Almeida - smfa@dem.ist.utl.pt  
Vanda Isabel Durães Geraldès - vanda.geraldès@clix.pt  
Isaac Issá Hacamo - isaac-hacamo@clix.pt  
Filipe Ricardo Roque Monteiro Maçarico - fricardo@dem.ist.utl.pt  
Inês Margarida Lima Azevedo - inesliaz@hotmail.com  
Damião Miguel Ribeiro de Medeiros - damiao@dem.ist.utl.pt  
David Filipe de Jesus dos Santos - dsantos@dem.ist.utl.pt  
Salomé de Brum Ferreira Ladeira - salome@aeiou.pt  
Pedro Rama - prama@clix.pt

## **II. Mission and Results**

### **1. Mission**

The activities of the Centre are multidisciplinary, linking basic and applied research to technology development, and focused on the issues of sustainability, namely in terms of the needs to secure the quality of the environment, together with the management of energy resources and the economic development. To achieve these objectives, the activities of the Centre are directed towards leading-edge developments and to promote the learning ability of graduate engineering students with the following specific goals:

- To improve knowledge in advanced fields of strategic technologies with emphasis on turbulent mixing and combustion processes, which have the potential to optimise the environment and the rational use of energy in industry;
- To develop and use advanced techniques for the analysis, monitoring and control of processes at laboratory and industrial scale, the later including technology and risk assessment.
- To promote the exchange of knowledge in advanced technologies for the optimisation of industrial processes, including the management of technology and innovation, as a way to promote competitive advantages at the corporate level;
- To derive science and technology policies and innovation strategies, namely in terms of environmental protection, rational use of energy and economic growth.

In this context, besides the development of basic research in energy and environmental-related processes, the Centre thus undertakes interdisciplinary research involving technology and policy, promoting ways in which industrial development can proceed in a sustainable and socially responsible manner.

In order to achieve these objectives, the Centre is organized in three main laboratories, aimed as follows:

- **LABORATORY OF THERMOFLUIDS, COMBUSTION AND ENERGY SYSTEMS**
  - To improve knowledge in advanced fields of strategic technologies with emphasis on turbulent mixing and combustion processes, which have the potential to optimise the environment and the rational use of energy in industry;
  - To develop and use advanced techniques for the analysis, monitoring and control of processes at laboratory and real scales.
  - To promote the exchange of knowledge in advanced technologies for the optimisation of industrial processes and energy systems
- **LABORATORY OF ENVIRONMENTAL SYSTEMS**
  - To develop and use advanced research methodologies for the analysis of environmental systems.

- To promote the exchange of knowledge in advanced technologies for the optimisation of industrial processes and environmental systems

- **LABORATORY OF TECHNOLOGY POLICY AND MANAGEMENT OF TECHNOLOGY**

- To develop and use advanced research methodologies for the analysis of techno-economic systems.
- To promote the exchange of knowledge in advanced technologies and the management of technology and innovation for the optimisation of industrial processes, as a way to promote competitive advantages at the corporate level;
- To derive science and technology policies and innovation strategies, namely in terms of socio-economic development.

## **2. Research Team Experience**

The R&D activities included in the present research programme, which have been particularly developed since 1998, have derived from those developed within the scope of the Combustion Laboratory of the Mechanical Engineering Department of I.S.T. for a number of years, which have been extended with the aim to integrate competencies at the level of technology policy and advanced socio-economic research methods. This is because the successful development and subsequent exploitation of energy and environment technologies requires, apart from improved knowledge of basic thermo-fluid mechanics, the understanding of policy issues and innovation strategies, in a context which promotes the sustainable development. The ultimate goal is to improve the process of industrial assimilation of knowledge, through a stepwise and interactive approach considering the overall values chain associated with industrial and corporate processes.

In addition, the activities developed in the last years have been planned on the basis that the most important challenges in maximising the impact of Science and Technology, S&T, on the well-being of nations, is to understand and maximising the complex processes that underlie world-class S&T research, commercialisation and management, including the protection of intellectual property and the integration of knowledge in a context of enhanced economic wealth and shared prosperity.

The concepts presented above are the result of a strong involvement of a number of researchers in a considerably large number of international R&D projects since 1986. These projects have been developed in the scope of national projects and the BRITE/EURAM, Science, STEP, Environment, Joule and Esprit Programmes of the European Commission, as well as an increasing involvement with Portuguese and European industry. Apart from the national sectors of glass and crystal, R&D links have been established for a number of years with major European aeronautical companies (Rolls Royce, SNECMA, TURBOMECA, MTU, Rolls-Royce- BMW) and process industries (Saint Gobain). Briefly, the work evolved from basic research on turbulent fluid mechanics and combustion, namely through several master and doctorates programmes. Moreover, the research work has gained considerably from the successive organisation of the Intl. Symposia on Applications of Laser Techniques to Fluid Mechanics, which have been held in Lisbon since 1982. The symposia have contributed significantly to promote a series of international contacts and research activities in international cooperation.

More recently, the development of competencies in the area of science, technology and innovation policy has been successfully achieved following three main lines of development, namely: i) advanced training of young researchers in leading American universities, through PhD. Programmes in leading and emergent topics; ii) launching in IST of the Master programme on “Engineering Policy and Management of Technology”

in 1998, which has allowed to train young people in new areas of education at IST and promote new links with Portuguese companies; and iii) the organization of the Intl. Conferences on Technology Policy and Innovation, which were launched in July 1997 and carried out in close collaboration with a number of leading research groups worldwide.

### 3. Research Topics and Results: Knowledge creation

#### 3.1 Laboratory of Thermofluids, Combustion and Energy Systems

The Laboratory is organised on the basis of *Research Areas*, which include a range of projects. These projects provide the necessary external funding, namely from national and international funding agencies and/or private companies. The following is a list of the main Research Areas, under which the most important activities under development are presented.

- **Turbulent mixing and combustion**
  - Improved understanding towards Lean Combustion
  - Shear-layer control and vortex-flame interaction
  - Non-premixed flame propagation in single and interacting combustion systems
  - Industrial burning equipment and energy systems
- **Thermo-Fluid-Dynamics of multiphase flows**
  - Liquid disintegration and spray formation
  - Turbulent Dispersion in multiphase flows
  - Dynamics of Spray-wall impingement
  - Heat transfer of impacting volatile poly-dispersions
- **Fire propagation and Risk Assessment**
  - Physical modelling of forest fire behaviour
  - Continuing training on technology-based hazards; support of specific studies and emergency plans; consulting on technology-based hazards.

Most of the research results achieved in these various areas may be summarized as follows.

#### a) Turbulent mixing and combustion

Shear-layer acoustic excitation: This work reports the experimental study conducted on a curved oscillatory boundary layer excited by a single frequency artificial signals. Physical analysis of turbulent shear layer morphology was based on instantaneous sequences of shadowgraph images and turbulent velocity characteristics by Laser Doppler Velocimetry measurements. The data was interpreted on a phase locked base to allow the characterization of the unsteady inner and outer shear layers that features to strong temporal and spatial deformations imposed by external induced oscillations. The analysis of vortex pairing dynamics allowed concluding that the pairing process in this flow corresponds to the jet column mode, as suggested for circular jet flow. The consequences of this flow behaviour into the combustion efficiency and pollutant reduction are being evaluated.

Oscillating swirling flows and the onset of PVC - experiments without chemical reaction- isothermal flow: The swirling flow in a combustor model was examined for the conditions characterized by the presence of a breakdown zone and precessing vortex core (PVC). As defined by acoustic measurements the flow in the primary zone of the combustor goes through certain development stages as the flow swirl intensity increases; a region of abnormal decreasing precession frequency was discovered. Direct LDA measurements revealed that these typical regimes are connected with the appearance and radial expansion of a central recirculating flow followed by PVC axial extension. A simple approximation for tangential velocity was used for reconstructing

the PVC parameters from the averaged flow characteristics. Finally, a cross-spectral analysis of two-point acoustic signals provided information on the mode structure of the pressure fluctuations imposed by the precessing core. These data include results on the spatial configuration of the PVC axis represented by circumferential and axial wavenumbers. The latter was used to decompose the measured precession frequency through parts related to the pure vortex core rotation and its translational motion. The significant effect distinguishing the present work consists in the fact that the greatest contribution to the flow pulsation frequency is due to the axial translation of the spiral vortex.

In addition, the variation of axial wavelength vs. swirl number showed jumplike changing that could be interpreted as a transition between the two breakdown modes referred to in the literature as “bubble” and “spiral” types. In our case the bubble breakdown mode corresponds to flow regime with the abnormal frequency dependency on swirling intensity.

Experiments with chemical reaction: The swirling flow in a lean premixed prevaporised combustor model (LPP chamber) is studied, making use of high-speed photography, LDV, sound-probes, fine-wire thermocouples and suction probes for chemical gas analysis. The experimental study, which involved parametric changes of  $Re$ ,  $S$  and  $\phi$  extends from the combustor primary zone to the premixing chamber, and was conducted with and without reaction, burning either gaseous propane or liquid fuel assisted with preheated air at 300°C. Measurements show that the swirling flow mixture that enters the primary zone of the combustor chamber shows evidence of a PVC structure, for  $S > 0.5$ , that embraces the central recirculation zone (CRZ). Further, reaction test results show that increasing the swirl number decreases CO and NO<sub>x</sub> concentrations at the combustor exit and reduces flame stability limits to levels close to the lean limit because of flashback. In addition, a detailed study of the reacting condition ( $S=1.05$ ,  $\phi=0.5$ ) was performed; the results indicate that the PVC is still present, embracing the base of the CRZ and staying in the inner shear layer where the flame should also be stabilized, contributing particularly to an abnormal radial distribution of  $W_{rms}$ . Large gradients of mean temperature and UHC concentration were found to be limited to the base of the CRZ.

#### **b) Thermo-Fluid-Dynamics of multiphase flows**

Unstable liquid films: An experimental study is made on thin flowing horizontal flows to analyse their natural instabilities. Parameters such as flow rate and initial thickness at the injector outlet were adjusted to span a wide range of conditions. Four different regimes were identified, as a result of the presence of a quasi-planar hydraulic jump for moderate flow rates. Film thickness was measured using a point contact method. Other measurements were performed: wavelength of the stationary waves found in the supercritical region, wave frequency and wave slope of the waves formed by the jump oscillations and which propagate through the sub critical region. Several phenomena such as hydraulic jump formation, momentum lost and wave properties clearly depend on the Weber number, as a result of the thinness of the film.

- Acoustic excitation of liquid-sheet disintegration process: The effect of acoustic excitation on the disintegration characteristics of air-assisted liquid sheets, which utilize water at ambient temperature, and for velocities up to 1.8 m/s, is investigated. The study using high-speed imaging techniques revealed that optimum frequency modulation of the perturbation generator has a pronounced influence on the associated surface waves

and the subsequent breakup of the liquid sheet. The analysis includes characterization of critical wave amplitude, breakup length and breakup frequency, for Weber numbers in the range  $0.30 < We_{abs.} < 0.44$ , which are compared with flow features in the absence of acoustic excitation. The results show that acoustic perturbation can effectively suppress the dominance of gravitational and surface tension effects. As a consequence, for low Weber number flows, the interfacial waves exhibit regularity, and thus a better control of primary breakup processes of liquid sheet may be accomplished.

Dynamics of two - phase flows: The research work performed in this field addresses the physical processes involved in the impingement of liquid sprays against solid surfaces, with emphasis on the effects of cross flow conditions and vaporization. The work plan includes experiments in simple flow configurations with well-controlled boundary conditions and the development of appropriate sub-models for impingement and evaporation. The experiments were built based on similarity analysis in order for the study to be relevant for practical applications. Here, the concern was the development of new concepts of mixture preparation in internal combustion engines.

A more efficient control of the fuel supplied to the cylinder requires a fundamental knowledge of the fuel spray behavior at the impact with the surface; drag, dispersion and vaporization by the cross flow; gaseous mixture formation and combustion. An experimental installation has been built, which considers a PFI injector spraying gasoline onto a flat surface at ambient temperature. Experiments are now being conducted considering time and frequency of injections, which approach cold start conditions in real engines. The measurements include time-resolved PDA measurements of droplet size, velocity and volume flux in the vicinity of the target surface. The analysis of the results highlights the main parameters describing spray-wall interactions, which are relevant to physical modelling.

Another experiment has been built aimed at to account for the complexity introduced by the influence of non-scaled parameters on the description of droplet impact. Measurements have considered the deformation and splash of droplets impinging onto dry flat surfaces of different materials and with different surface profiles. The results showed that the nature of the target surface significantly alters the onset of splashing and the dimensionless roughness  $Ra/Ro$  alone does not describe completely the nature of the surface. Other characteristics describing the surface profile may also be considered, but more systematic measurements are still necessary in order to develop appropriate correlations. Also, the experiments will be used to develop appropriate physical models to describe the energy dissipated at the wall during droplet deformation.

### **c) Fire propagation and Risk Assessment**

Physical modelling of forest fire behaviour: The physical modeling of forest fire behaviour has been carried out based on two-dimensional models of fire spread across a bed including wind combined with slope conditions. In addition, the characterization of forest fire propagation in a pine needles fuel bed was also performed in the context of a Master's degree dissertation.

The forest fuel bed is a typical porous medium whose characteristics (shape and size of the particles, bulk density, packing ratio) modify the gas flow behind and ahead of the flame. In this context, current work coordinated by João Ventura and José Miguel Mendes Lopes includes the study of the following parameters: i) the variation of pressure drop with the main properties of the medium (fuel type, bulk density, packing ratio), and ii) heat transfer within the fuel bed, leading to the determination of the convection coefficient and its dependence on the main properties of the medium.

A computer code to simulate surface forest fire behaviour in heterogeneous terrain is

being developed and optimised to run in a simple PC platform, but in a way which is compatible with GIS (ARCVIEW). It computes the burned area shape and evolution, as well as local results on rate of spread, flame length, fire line intensity, reaction intensity, and local times of beginning and end of propagation. It is based on FIRE1 from BEHAVE, and uses cellular automata to extend the use of FIRE1 to heterogeneous terrain and heterogeneous meteorological conditions.

Technological Risk Analysis and Support to the National Service of Civil Protection  
Geographical Information Systems have been adapted and used to characterize natural risks in Portugal, with particular reference to the south and the zone of Alentejo. A plan of work in close collaboration with the National Service of Civil Protection is being coordinated by João Ventura in the following areas:

- Continuing training of the staff of the National Service of Civil Protection on technology-based hazards;
- To support specific studies and emergency plans;
- Consulting on specific aspects related with technology-based hazards.

In addition, risk assessment of "Transportation of Dangerous Substances in Portugal" has been initiated aimed to characterize the flow of dangerous substances in the Portuguese territory and to gather information to assist emergency management of accidents, which may occur in this kind of transportation.

### **3.2 Laboratory of Environmental Systems**

The research work under this theme has been aimed to develop and use advanced research methodologies for the analysis of complex systems and to promote the exchange of knowledge in advanced technologies for the optimisation of environmental systems. It involves the following main topics:

- Industrial Ecology Toolbox
  - Design for Environment – DFE
  - Hybrid Economic Input-Output Life Cycle Assessment – H-EIO-LCA
- Environmental Policy and Industrial Ecology Systems
  - The environment and the automobile
  - Ecological economics
  - Energy and environment
- Environmental physics

#### **a) Industrial Ecology Toolbox**

The research work developed is aimed at demonstrating the need to prepare the evolution to a new "Industrial Ecology stage". The requirements to step up to this new stage are classified at three levels, the need for an appropriate "environmental analysis methodologies toolbox", the establishment of a structured set of indicators to support sustainable policies and priority setting at a regional level, and finally, the development of a new organization of infra-structures, technologies, sectors and firms to promote co-operation between the various actors involved within an Industrial Ecology framework

## **b) Environmental Policy and Industrial Ecology Systems**

The physical nature of the economy is emerging as a new paradigm, based on increasing public recognition of environment-economy interconnections. In this context, modern economies can be seen as ingesting raw materials, which are metabolised into products and services and also waste, in the form of materials/products without use and pollution. Environment-economy interconnections are dependent on economic activity fields or sectors, on the existing local infrastructures and future technological options, i.e. on the time and length scales imposed by the local-regional interactions at different levels (economic, regulatory, technological). The research developed concludes that innovation in environmental technologies may shift the spirit of product-oriented regulations and give rise to more efficient approaches if a transversal, Industrial Ecology perspective, integrating different products life cycles is adopted.

## **c) Environmental Physics**

The scientific activity in environmental physics has been developed within the framework of the project SAPIENS: POCTI/1999/CTA/35626 - Carbon Balance of Eucalypt Plantations in Portugal- the Kyoto Forest Problem. In the context of the Kyoto protocol, the activity developed is aimed at evaluating the magnitude, seasonality and repartition of the carbon fluxes and stocks in a Eucalyptus forest. Ultimately, the aim is to evaluate the potential of the eucalyptus forest to act as a carbon sink. The research performed is mainly experimental and, as a consequence, a significant effort has been dedicated to set up an experimental rig at the Herdade da Espirra, Pegões.

### **3.3 Laboratory of Technology Policy and Management of Technology**

The work has drawn on recent conceptual approaches to economic growth, in which the accumulation of knowledge is the fundamental driving force behind growth. This fact is reflected in the trend in developed economies towards an increasing investment in advanced technology, research and development, education, and culture. Concepts such as learning ability, creativity and sustained flexibility gain greater importance as guiding principles for the conduct of individuals, institutions, nations and regions. It is thus legitimate to question the traditional way of viewing the role that contemporary institutions play in the process of economic development and to argue for the need to promote *systems of innovation and competence building* based on learning and knowledge networks. Under the broad designation of “learning and knowledge networks”, the research results discuss the necessary balance between the creation and diffusion of knowledge and contribute to improve our understanding of the dynamics of the process of knowledge accumulation, which drives a learning society.

- Systems and Policies for Knowledge Creation, Diffusion and Usage
  - Higher Education Policy and Management
  - S&T and Innovation
- Learning Economy
  - Towards a "Learning Society"
  - Technology and Economic Inequality
- Management of Technology and Policy Implications
  - Globalization, diversification and technology capacity in the auto parts sector

- Mobilizing information and communication technologies: implications for regional development
  - New energy systems: photovoltaic
- Strategy, Entrepreneurship and Technical change
  - Collaborative Learning and Virtual Teaming
  - Fostering entrepreneurship at the University

#### **4. Beyond Research: Knowledge Transfer and Diffusion**

The activities performed beyond the research work, but closely linked to the various R&D activities reported before, are described under the following themes:

- Advanced Training – Main Post-Graduation Education Programmes
- Advanced Training – Workshops
- Main R&D Projects
- C&T commercialisation activities
- International Conference Series
- Main Editorial Activities

##### **4.1 Advanced Training – Main Post-Graduation Education Programmes**

The R&D activities performed at IN+ have been planned in close collaboration with various post-graduation programmes at IST, under which new young researchers are formed. One main programme is directly coordinated by members of IN+, and this programme have been particularly developed making use of IN+ resources:

- Master in “Engineering and Management of Technology”,  
<http://in3.dem.ist.utl.pt/master/>

#### **Thesis concluded:**

##### **Master:**

- **Title:** Development Policies for the Biotechnology Industry in Portugal  
**Student:** Carla Maria do Rosário Costa  
**Supervisors:** Dr. Manuel Frederico Tojal de Valsassina Heitor  
Dr. Maria Margarida Duarte Castro Fontes  
**Date:** November 2001
- **Title:** Perspectives for Technological Innovation for the Portuguese Hand Made Glass Sector  
**Student:** Alberto Carlos Brás Diogo  
**Supervisors:** Prof. Manuel Frederico Tojal de Valsassina Heitor  
Prof. Paulo Manuel Cadete Ferrão  
**Date:** April 2001
- **Title:** Make-to-Stock vs. Make-to-Order in Glass Manufacturing  
**Student:** Nuno Manuel Rosa dos Santos Órfão  
**Supervisors:** Prof. Carlos Filipe Gomes Bispo  
Prof. Paulo Manuel Cadete Ferrão  
**Date:** February 2001
- **Title:** Learning Dynamics in transition economies: Case studies in the auto-parts sector in Portugal  
**Student:** Alexandre Ricardo Garção Nunes Videira  
**Supervisors:** Prof. Manuel Frederico Tojal de Valsassina Heitor  
Dr. Francisco Miguel Rogado Pinheiro Veloso  
**Date:** March 2001
- **Title:** Production Cost Modeling for the Automotive Industry  
**Student:** António José Marques Monteiro  
**Supervisors:** Prof. Carlos Filipe Gomes Bispo  
Dr. Francisco Miguel Rogado Pinheiro Veloso  
**Date:** September 2001
- **Title:** Competitiveness factors for the auto-parts industry: determinants of quality  
**Student:** Luís Carlos Pereira Batista Reis

**Supervisors:** Prof. Manuel Frederico Tojal de Valsassina Heitor  
Dr. Rui Miguel Loureiro Nobre Baptista  
Dr. Francisco Miguel Rogado Pinheiro Veloso

**Date:** July 2001

- **Title:** Critical factors for improved inter-firm cooperation  
**Student:** Teresa Maria de Oliveira Rolo  
**Supervisor:** Dr. Rui Miguel Loureiro Nobre Baptista  
**Date:** March 2001
- **Title:** Strategies to Integrated Management of Waterbodies Pollution  
**Student:** Ana Paula de Sousa Teixeira  
**Supervisors:** Dr. José Manuel de Saldanha Gonçalves Matos  
Dr. António Jorge Monteiro  
**Date:** June 2001
- **Title:** Environmental Input-Output Analysis: Application to Portugal  
**Student:** Marta Alexandra Sousa e Silva  
**Supervisor:** Prof. Paulo Manuel Cadete Ferrão  
**Date:** July 2001
- **Title:** A Study on the Deregulation of the Electricity Sector and the Implications for the Portuguese Market  
**Student:** Marta Isabel da Costa Paiva Pinto  
**Supervisor:** Dr. Rui Miguel Loureiro Nobre Baptista  
**Date:** January 2001
- **Title:** Are Environmental Concerns Drivers of Innovation? Evidence from the Community Innovation Survey Results for Portugal  
**Student:** Pedro Miguel dos Santos Vieira  
**Supervisors:** Prof. Manuel Frederico Tojal de Valsassina Heitor  
Prof. Francisco Nunes Correia  
Prof. Pedro Filipe Teixeira da Conceição  
**Date:** June 2001
- **Title:** A Study on Internet Impact in Business Designs for the Health Sector  
**Student:** Carlos Manuel Valente Quiterio Simão  
**Supervisor:** Dr. Rui Miguel Loureiro Nobre Baptista  
**Date:** August 2001
- **Title:** Fostering the Digital Economy: Perspectives for Internet Clustering  
**Student:** Hongyun Meng  
**Supervisors:** Prof. Manuel Frederico Tojal de Valsassina Heitor  
Prof. Pedro Filipe Teixeira da Conceição  
**Date:** April 2001
- **Title:** On the use of Offsets to foster Technological Innovation: A Methodology for Case Analysis  
**Student:** João Pedro Taborda da Silva  
**Supervisors:** Prof. Manuel Frederico Tojal de Valsassina Heitor  
Prof. Pedro Filipe Teixeira da Conceição  
**Date:** September 2001
- 
- 

#### **4.2 Advanced Training – Workshops**

The advanced Workshop series on “Science, Technology and Society”, <http://in3.dem.ist.utl.pt/adv/workshops/>, developed through IN+ act as a forum to exchange ideas and an opportunity of scientifically discussing the global changes on the

development and use of science and technology and related social and ecological consequences.

Analysis has shown that continuous technical change in business firms in modern societies require the close development of publicly funded research and associated training, so that the development of a country's science base is socially shaped (e.g. Pavitt, 1998; Research Policy). In this context, technology is not simply a tool or applied science, nor is science simply the result of knowledge accumulation. Rather, science and technology are characterized by their entrenchment in society, thus requiring both interdisciplinary reflection and development of real-world strategies for action.

Based on this background, innovation has been increasingly considered as a key factor in corporate and socio-economic performance and analysis has shown the importance of decentralized industrial policy in support of wealth creation and the well-being of future generations. The workshops has taken place during one or two consecutive days, including only plenary sessions. Emphasis were given to structural aspects, namely through lectures delivered by national and international experts with the purpose of introducing fundamental concepts associated with the development of Science and Technology Policies. Technical sessions included expert topics which have raised world-wide attention, with emphasis on challenges and opportunities faced by engineers and researchers and technology managers in the context of the current European innovation policy.

The main workshops realized during 2001 were as follows:

- Workshop Dec.01: December 15, 2001  
Partnerships for Innovation: Fostering Industry-Science Relationships  
<http://in3.dem.ist.utl.pt/adv/workshops/wk3b.html>
- Workshop Jun.01: June 21-23, 2001  
Learning by Comparing US and European experiences on Innovation and Competence Building  
<http://in3.dem.ist.utl.pt/innov2001/>
- Workshop Feb.01: February 1, 2001  
Rethinking Engineering Education to Foster Design Engineering for Sustainable Development  
<http://in3.dem.ist.utl.pt/design/>

#### **4.3 Main R&D Projects**

The following are the main R&D projects developed during 2001 by researchers at IN+:

- Direct Injection Spray Engine Processes - Mechanisms to Improve performance, Project DIME – ENK6-2000-00101  
Project Coordinator: Prof. Manuel Heitor
- “Dynamics and Control of Flame Stabilization and Propagation for Advanced Energy Systems”.  
FCT-PCTI/1999/EME/34768, 1999-2003  
Project Coordinator: Prof. Edgar Fernandes
- TRESHIP- Technologies for Reduced Environmental Impact from Ships  
Instituto Superior Técnico, 1999-2003.  
Brite-Euram thematic network: BRRT-CT98-509.  
Project Coordinator: Prof. Paulo Ferrão

- “Inauto Autointeriores – Caracterização das Estratégias de Criação de Oportunidades e Promoção de Inovação ao Nível dos Materiais para o Interior de Veículos”  
Instituto Superior Técnico, 2001-2003.  
(Projecto financiado pelo Centro para a Excelência e Inovação na Indústria Automóvel, através do Programa Operacional da Economia)  
Project Coordinator: Prof. Paulo Ferrão
- “Ecotech – Apoio ao Desenvolvimento Eco-eficiente de Componentes Automóvel”  
Instituto Superior Técnico, 2001-2003.  
(Projecto financiado pelo Centro para a Excelência e Inovação na Indústria Automóvel, através do Programa Operacional da Economia)  
Project Coordinator: Prof. Paulo Ferrão
- “MOD. VFV – “Desenvolvimento de um modelo temático que simule a infraestrutura nacional de processamento de veículos em fim de vida”  
Instituto Superior Técnico, 2001-2003.  
Project Coordinator: Prof. Paulo Ferrão
- “A interacção entre partículas e estruturas turbulentas numa camada limite: Aplicação de diagnósticos laser para o estudo de transporte de sedimentos”  
Instituto Superior Técnico, 2000-2004.  
Projecto POCTI/EME/34183/2000.  
Project Coordinator: Prof. Paulo Ferrão
- “Estudo de instabilidades precessionais do tipo vórtice helicoidal em câmaras de combustão de turbinas a gás com vista a obter baixos níveis de emissão dos poluentes CO e Nox”.  
Instituto Superior Técnico.  
Projecto: FCT/SAPIENS99/PCTI/1999/EME/34768  
Project Coordinator: Prof. Edgar Fernandes
- “Flow and heat transfer characteristics of evaporating impinging sprays”  
Projecto POCTI/1999/EME/32960.  
Instituto Superior Técnico, 2001-2004.  
Project Coordinator: Prof. António Luis Moreira
- “INAUTO – Design studios e gestão da tecnologia na industria automóvel”  
Instituto Superior Técnico, 2001-03.  
Projecto financiado pelo POE  
Project Coordinator: Prof. Manuel Heitor
- “Estudo de Oportunidade e Viabilidade de Instalação em Portugal de uma Unidade Industrial Destinada à Produção de um Veículo Automóvel de Nicho”  
Instituto Superior Técnico, 2001-2003.  
(Projecto financiado pelo Centro para a Excelência e Inovação na Indústria Automóvel, através do Programa Operacional da Economia)  
Project Coordinator: Prof. Paulo Ferrão
- OCT / CIS III – “Proposta para a Execução do CIS III e de Obtenção de Informação sobre Inovação em Portugal Complementar à do CIS II”  
Instituto Superior Técnico, 2001-03.

Projecto financiado pelo OCT/MCT  
Project Coordinator: Prof. Pedro Conceição

- OCT INOVAÇÃO – “Elementos para a Compreensão da Inovação em Portugal”  
Instituto Superior Técnico, 2001-03.  
Projecto financiado pelo OCT/MCT  
Project Coordinator: Prof. Manuel Heitor
- “Striving for Early Successes, Tapping on Existing Resources”  
Instituto Superior Técnico, 2001-02.  
Projecto financiado pela SOLVAY Portugal  
Project Coordinator: Prof. Manuel Heitor

#### **4.4 C&T commercialisation activities**

The Center has been involved in fostering C&T commercialization activities in a way to promote the creation and diffusion of knowledge beyond academia, by establishing conditions that will:

- Stimulate university entrepreneurship, through student and staff involvement in technology commercialisation projects;
- Foster advanced training and qualifications in technological platforms, by combining technical skills with a broader vision of the relationship between new technologies with economy and society;
- Promote entrepreneurial projects and the diffusion of applications/contents for new technologies.

The main project developed during 2001 was as follows:

- “Green.Wheel ”  
<http://www.green-wheel.net/>  
(Financiamento público : POE)  
Coordinator: Prof. Manuel Heitor

The **Green-Wheel Programme** is aimed at promoting technology-based entrepreneurship according to concepts that will foster sustainable human and entrepreneurial development, including the necessary development of new applications/contents associated with information and communication technologies, as well as a vast range of environment technologies, production processes, biotechnology and industrial processes that may directly contribute to sustainable development.

#### **4.5 International Conferences**

The Center promotes the transfer and diffusion of knowledge through the organization of major international Conferences, which have considerably contributed to diffuse knowledge worldwide, and promote the internationalization of the Portuguese S&T system. Emphasis has been given, since 1982, to the application of laser techniques for fluid flow research, and this has contributed for the organization of a world leading conference in Lisbon every two years. Current activities include also the analysis of socio-economic research topics, namely looking at the role of knowledge for development. This has resulted in the organization of an international series of annual Conferences around the world.

The following are the most significant events planned and realized during 2001:

- **International Symposia on Applications of Laser Techniques to Fluid Mechanics**

The Symposia have contributed since 1982 for the presentation of new research on advanced techniques for flow measurement and results of significance to fluid mechanics. It has emphasized the application of laser, and other advanced techniques, to scientific and engineering investigations of fluid flow. Contributions to the theory and practice of measurement methods have been accepted where they facilitate new improved fluid mechanical investigations, and have included laser-Doppler velocimetry, LDV, phase-Doppler velocimetry, particle image velocimetry, PIV, and laser induced fluorescence and other scalar diagnostics. Non-optical techniques that provide new and reliable information on fluid flows, heat and mass transfer and complement that obtained with laser diagnostics have also been considered for the various International Symposia.

The 11<sup>th</sup> Symposium was planned during 2001, following previous Symposia. It should be noted that these Symposia have been launched in July 1982, in Lisbon, through a close partnership involving Professors Jim Whitelaw, Imperial College, Franz Durst, University of Erlagen, Ron Adrian, University of Illinois, and Diamantino Durão, IST. Since then, the Conferences have been organized in Lisbon, every two years, based on a close collaboration between the Center for Innovation, Technology and Policy Research, IN+, of the Instituto Superior Tecnico in Portugal, and the researchers mentioned before.

- **International Conferences on Technology Policy and Innovation**

The main objective of this series of international conferences on Technology Policy and Innovation is to bring together leading representatives of academic, business, and government sectors worldwide to present and discuss current and future issues of critical importance for using science and technology to foster regional economic development and shared prosperity at home and abroad . Multidisciplinary perspectives are encouraged to provide state-of-the-art and useful knowledge to decision makers in both the private and public sectors – including informed and effective education, business, and government policies and strategies for the global, knowledge economy.

The 1st International Conference on Technology Policy and Innovation was held in Macau, off the coast of China, July 2-4, 1997, with the theme “21st Century Opportunities and Challenges for Science, Technology and Innovation Policy”. The 2nd conference was held in Lisbon, Portugal, August 3-5, 1998, with the theme “Knowledge for Inclusive Development”. The 3rd Conference was held in Austin, Texas, August 30-September 2, 2000, with the theme “Global Knowledge Partnerships: Creating Value for the 21st Century”. The 4th Conference was held in Curitiba, Brazil, in August 2000, focusing on "Learning and knowledge networks for development". In 2001, the 5th Conference was held in Delft, the Netherlands, focusing on "Critical Infrastructures".

These Conferences have been organized based on a close partnership between the IC2 Institute of The University of Texas at Austin, USA, and the Center for

Innovation, Technology and Policy Research, IN+, of the Instituto Superior Tecnico in Portugal, but involving other major partners, as the Institute for International Studies of the Stanford University, USA, the Science and Technology Policy Research Unit of the University of Sussex, SPRU, UK, the Institute of Studies on Scientific Research of the Italian National Research Council and the Delft University of Technology.

#### **4.6 Main Editorial Activities**

The following is a list of major editorial activities by members of IN+ during 2001:

- Technological Forecasting & Social Change - Special Issues  
Special Issues on "Science, Technology and Innovation Policies", as in <http://in3.dem.ist.utl.pt/tfsc/>
  - Intl J. Technology, Policy and Management - Special Issues  
Special Issues on "Technology, Policy and Management", as in [http://in3.dem.ist.utl.pt/s\\_issue/](http://in3.dem.ist.utl.pt/s_issue/)
  - International Book Series on "Technology Policy and Innovation"  
The main objectives of this series, <http://in3.dem.ist.utl.pt/istpi/>, are:
    - to publish leading scholarly work representing academic, business, and government sectors worldwide on technology policy and innovation; and
    - to present current and future issues of critical importance for using science and technology to foster regional economic development and shared prosperity.
- General Editors:
- Manuel V. Heitor, Center for Innovation, Technology and Policy Research, Instituto Superior Técnico, Lisbon, Portugal
  - David V. Gibson, IC2 Institute, The University of Texas at Austin, Texas
  - Pedro Conceição, Center for Innovation, Technology and Policy Research, Instituto Superior Técnico, Lisbon, Portugal and
- Our Books through IST PRESS:
    - M. Heitor and J. Duarte (2001). GLASS CHAIR: Competence Building for Innovation. Lisbon: IST Press.
  - Other publications through the Portuguese Observatory for Science and technology:
    - M. Heitor (2001), "National evaluation of R&D Units in Portugal" (in Portuguese), Portuguese Ministry of Science and Technology.

**Annex 1: Indicators** (as required by Portuguese Science and Technology Foundation, FCT)

	Previsto	Realizado
Livros	<b>3</b>	3
Artigos em Revistas Internacionais	<b>13</b>	15
Artigos em Revistas Nacionais	<b>4</b>	3
Comunicações em Encontros Científicos Internacionais	<b>12</b>	12
Comunicações em Encontros Científicos Nacionais	-	-
Relatórios	-	-
Organização de Seminários e Conferências	-	-
Teses de Doutoramento	-	-
Teses de Mestrado	<b>14</b>	12
Outras		
Modelos		
Aplicações Computacionais		
Instalações Piloto		
Protótipos Laboratoriais		
Patentes		
Outros		

## **Annex 2. List of Main Publications in 2001**

### **Books**

- P. Conceição, P. Ávila (2001), *A Inovação em Portugal: O Segundo Inquérito Comunitário às Actividades de Inovação [Innovation in Portugal: Results from the Second Community Innovation Survey, in Portuguese]*, Lisbon: Celta Editora.
- M. Heitor and J. Duarte (2001). *GLASS CHAIR: Competence Building for Innovation*. Lisbon: IST Press.
- M. Heitor (2001), “National evaluation of R&D Units in Portugal” (in Portuguese), Portuguese Ministry of Science and Technology.

### **Technical papers in International Journals and books**

#### Laboratory of Environmental Systems

- F. Freire, A. Figueiredo and P. Ferrão (2001) “Modelling high-temperature, thin-layer, drying kinetics of olive bagasse”. *Journal of Agricultural Engineering Research*, 78, (4), pp397-406.
- D.P. Correia, P. Ferrão, and A. Caldeira-Pires (2001) “Advanced 3D emission tomography flame temperature sensor”, *Combustion Science and Technology*, 163, pp. 1-24.
- F. Freire, S. Thore and P. Ferrão (2001) “Life Cycle Activity Analysis: Logistics and environmental policies for bottled water in Portugal”, *OR Spektrum*, 23, (1), pp. 159-182.

#### Laboratory of Technology Policy and Management of Technology

- P. Conceição, D. Gibson, M. V. Heitor, and G. Sirilli (2001), “Beyond the Digital Economy: A Perspective on Innovation for the Learning Society”, *Technological Forecasting and Social Change*, 67(2-3):115-142.
- Conceição, P., Gibson, D. V., Heitor, M.V. and Sirilli, G. (2001). "Knowledge for Inclusive Development: The Challenge of Globally Integrated and Learning Implications for Science and Technology Policy", *Technological Forecasting and Social Change*, 66, pp. 1-29.
- P. Conceição, M. V. Heitor (2001), “Towards a University Agenda on Engineering Policy and the Management of Technology,” *International Journal of Technology, Policy and Management*, 1(2): 195-227.
- Conceição, P., and Heitor, M.V. (2001). "Universities In The Learning Economy: Balancing Institutional Integrity with Organizational Diversity”, in : "The Globalising Learning Economy: Major Socio-Economic trends and European innovation Policy", Eds. Bengt-Aake Lundvall and Daniele Archibugi, Oxford University Press, pp. 83-96.
- Bommer, M., Heitor, M.V., Vedovelho, C., and Pissarra, P. (2001), "Biotechnol Pharmaceutica”, *Business Case Journal*, 9(1), pp. 107-119. Reprinted in Dignan, Les, (2002) *Strategic Management: Cases for the Global Information Age*, Dame/Thomson Learning, Cinc. pp. 30.1 – 30.11.
- P. Conceição, M. V. Heitor (2001). “Building a Manifesto for Engineering Education Renewal,” in M. V. Heitor, J. Duarte(eds.), *The Glass Chair*. Lisbon: IST Press.
- P. Conceição, P. Ferreira, James K. Galbraith (2001), “Inequality and Unemployment in Europe: The American Cure”, in James K. Galbraith and Maureen Berner (eds.), *Inequality and Industrial Change: A Global View*, Cambridge University Press: Cambridge, UK; New York: 109-138.
- P. Conceição, James K. Galbraith (2001), “A New Kuznets Hypothesis: Theory and Evidence on Growth and Inequality”, in James K. Galbraith and Maureen Berner (eds.), *Inequality and Industrial Change: A Global View*, Cambridge University Press: Cambridge, UK; New York: 139-160.
- P. du Pin Calmon, P. Conceição, James K. Galbraith (2001), “The Evolution of Industrial Earnings Inequality in Mexico and Brazil”, in James K. Galbraith and Maureen Berner (eds.), *Inequality and Industrial Change: A Global View*, Cambridge University Press: Cambridge, UK; New York: 227-237.

- P. Conceição, James K. Galbraith (2001), “Constructing Long and Dense Time-Series of Inequality Using the Theil Index”, in James K. Galbraith and Maureen Berner (eds.), *Inequality and Industrial Change: A Global View*, Cambridge University Press: Cambridge, UK; New York: 263-279.

### **Technical papers and communications in International Conferences**

#### Laboratory of Thermofluids, Combustion and Energy Systems

- Anacleto P.M., Fernandes E.C., Heitor M.V., Shtork S.I. Characteristics of precessing vortex core in the LPP combustor model. Abs. to the Int. Conf. on Stability and Turbulence of Homogeneous and Heterogeneous Flows, Novosibirsk, April, 25 - 27, 2001, Vol. 8, Kozlov V.V. (Ed.), Institute of Theoretical and Applied Mechanics SB RAS, Novosibirsk, 2001, pp. 14-15.
- Anacleto P.M., Fernandes E.C., Heitor M.V., Shtork S.I. Characteristics of precessing vortex core in the LPP combustor model. Proc. Second International Symposium on Turbulence and Shear Flow Phenomena, June 27-29, 2001, Stockholm, Sweden. Lindborg E. et al. (Eds.), KTH, Stockholm, 2001, Vol. 1, pp. 133-138.
- Kuibin P.A., Okulov V.L., Shtork S.I. Self-induced motion of helical vortex and phenomenon of precessing vortex core. Abs. to the 426th Euromech Colloquium on Swirling Flows, Norway, September 16-20, 2001.
- Moita, A. S. H. e Moreira, A. L. N. (2001), “Motores de Injecção Directa: estudo dos processos dinâmicos de deformação das gotas de combustível quando incidem na cabeça do pistão”, 1<sup>as</sup> Jornadas Politécnicas de Engenharia, 14 – 16 Novembro, 2001.

#### Laboratory of Environmental Systems

- Ferrão, P., Amaral, J. (2001) “The impact of EU legislation on ELV (End-of-Life Vehicles) processing infrastructures”. 5th International Conference on Technology Policy and Innovation” Delft, the Netherlands, 26-29 June,2001
- Nhambiu, J., Ferrão, P., Baptista, M., Quintela, M. (2001) “Environmental accounting of the Portuguese Economy”. 5th International Conference on Technology Policy and Innovation”. ConnAccount Conference. Stockholm, Sweeden, 26-29 June,2001.
- Canas, A., Ferrão, P., Conceição, P. (2001) “Material inputs of the Portuguese economy: the DMI approach”. 1st International Society or Industrial Ecology Conference— The science and Culture of Industrial Ecology, Leiden, The Netherlands, November, 12th- 14th, 2001.
- Canas, A., Ferrão, P., Conceição, P. (2001) “Testing the Kuznets Environmental Curve in the Input of Materials in Economy”. 1st International Society or Industrial Ecology Conference— The science and Culture of Industrial Ecology, Leiden, The Netherlands, November, 12th- 14th, 2001.
- Vargues, A. e Pita, G. (2001), Validation of A Tomato Growth Model Inside Non-Heated Greenhouses Located In Mediterranean Regions, , "Joint Meeting On Modeling For The 21 Century: Agronomic And Greenhouse Crop Models", USA, March 2001.
- Vargues, A. e Pita, G. (2001), Validação De Um Modelo De Crescimento Nas Condições Climáticas Do Litoral Alentejano, Poster, IV CONGRESSO IBÉRICO DE CIENCIAS HORTÍCOLAS,7-11 Maio 2001, Cáceres, Espanha
- Pita, G. e Santos, B. (2001), Contribuição para a Zonagem de Estufas em Portugal, Workshop 'Zonagem Climática de Portugal Para A Utilização de Estufas', Ineti , 22 Novembro 2001.

#### Laboratory of Technology Policy and Management of Technology

- P. Conceição, M. V. Heitor (2001), “Promoting knowledge infrastructure in Europe based on networks of research excellence and S&T Competences”, Proc. 5th International Conference on Technology Policy and Innovation” Delft, the Netherlands, 26-29 June,2001.

### **Technical papers in National Journals and books**

- P. Conceição, M. V. Heitor (2001), “Uma Interpretação sobre a Influência das Dinâmicas de Mudança Tecnológica na Inovação em Portugal”, Livro de Actas da IV Conferência sobre Economia Portuguesa, 4-5 May, ISEG, Lisbon, Portugal.
- Conceição, P. (2001), Desajustamentos entre Ganhos e Habilitações na Economia Portuguesa (2001) [Mismatch between Gains and Skills in the Portuguese Economy, in Portuguese], Collecção Cadernos de Emprego, 27, Lisbon: Direcção Geral do Emprego e Formação Profissional, Ministério do Trabalho [Portuguese Ministry of Employment].
- P. Conceição (2001). “Notas sobre a Produtividade em Portugal,” [Notes on Productivity in Portugal] in Vitor Santos (ed.), Globalização, Políticas Públicas e Competitividade [Globalization, Public Policy and Competitiveness]. Lisbon: Celta Editora: 187-227.
- Lages, P. e Ferrão, P. (2001) “Contribuição da energia solar térmica para a redução das emissões nacionais de gases de efeito de estufa”. Energia Solar, Revista de Energias Renováveis e Ambiente. Nº 49, ano 15, pp. 38-45.

### **Master thesis**

- Carla Costa (2001), Development Policies for the Biotechnology Industry in Portugal, IST – Engineering Policy and Management of Technolog
- Alberto Diogo (2001), Perspectives for Technological Innovation for the Portuguese Hand Made Glass Sector, IST – Engineering Policy and Management of Technolog
- Nuno Órfão (2001), Make-to-Stock vs. Make-to-Order in Glass Manufacturing, IST – Engineering Policy and Management of Technolog
- Alexandre Videira (2001), Learning Dynamics in transition economies: Case studies in the auto-parts sector in Portugal, IST – Engineering Policy and Management of Technolog
- António Monteiro (2001), Production Cost Modeling for the Automotive Industry, IST – Engineering Policy and Management of Technolog
- Luís Reis (2001), Competitiveness factors for the auto-parts industry: determinants of quality, IST – Engineering Policy and Management of Technolog
- Teresa Rolo (2001), Critical factors for improved inter-firm cooperation, IST – Engineering Policy and Management of Technolog
- Ana Teixeira (2001), Strategies to Integrated Management of Waterbodies Pollution, IST – Engineering Policy and Management of Technolog
- Marta Silva (2001), Environmental Input-Output Analysis: Application to Portugal, IST – Engineering Policy and Management of Technolog
- Marta Pinto (2001), A Study on the Deregulation of the Electricity Sector and the Implications for the Portuguese Market, IST – Engineering Policy and Management of Technolog
- Pedro Vieira (2001), Are Environmental Concerns Drivers of Innovation? Evidence from the Community Innovation Survey Results for Portugal, IST – Engineering Policy and Management of Technolog
- Carlos Simão (2001), A Study on Internet Impact in Business Designs for the Health Sector, IST – Engineering Policy and Management of Technolog
- Hongyun Meng (2001), Fostering the Digital Economy: Perspectives for Internet Clustering, IST – Engineering Policy and Management of Technolog
- João Pedro Silva (2001), On the use of Offsets to foster Technological Innovation: A Methodology for Case Analysis, IST – Engineering Policy and Management of Technolog