

Associated Laboratory – ISR: Report 2002
Theme C: Sustainable Technologies and 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 industrial processes and environmental systems. It involves 5 main topics, as follows.

1. 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. The following papers were developed in this context:

- J. Ehrenfeld, P. Ferrão and I. Reis (2002) “Tools to support innovation of sustainable product systems”, in: Knowledge for the Inclusive Development, pp. 417-433. Eds. P. Conceição, D. Gibson, M. Heitor and F. Veloso, Quorum Books.

Life Cycle Assessment – LCA:

- Ferrão, P., Ribeiro, P. and Silva, P. (2002). Avaliação de Ciclo de Vida de Embalagens de Bebidas e Bens Alimentares em Portugal Continental. Jornadas SPV, Lisboa, Sociedade Ponto Verde, 23 de Abril de 2002. [In Portuguese]

Design for Environment – DFE:

- S. Thore and P. Ferrão (2002) “The environmental impact of new products.”, in: Technology Commercialisation: DEA and related analytical methods for evaluating the use and implementation of technical innovation, pp 277-290. Edited by S. Thore, Kluwer Academic Publishers .
- Ferrão, P., J. Amaral and P. Silva. 2003. Laying the foundations for a DfR tool for auto components. 14TH International Conference on Engineering Design ICED 03 Stockholm.

Hybrid Economic Input-Output Life Cycle Assessment – H-EIO-LCA:

- Ferrão, P. (2002). The use of EIO-LCA in assessing National Environmental Policies under the Kyoto Protocol: the Portuguese Economy. 6th International Conference on Technology Policy and Innovation, Kansai, Japan, 12-15 August 2002.

Material Flow Analysis – MFA:

- Canas, A., Análise da Intensidade de Utilização de Materiais na Economia, Dissertação para obtenção do Grau de Mestre em Engenharia e Gestão de Tecnologia, Departamento de Engenharia Mecânica, Instituto Superior Técnico, 2001.

System Dynamics – SD:

- Amaral, J., P. Ferrão and C. Rosas. 2002. Is recycling technology innovation a major driver for technology shift in the automobile industry under a EU context?. In Proceedings of the 6th International Conference on Technology, Policy and Innovation - Integrating Regional and Global Initiatives In the Learning Society. Kansai. August 2002.

2. 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.

The following papers were developed in this context:

Automotive

- Ferrão, P., Amaral, J. and Reis, I. (2002). "The Industrial Ecology of the Automobile: a Portuguese Perspective." *International Journal of Ecology and Environmental Sciences*(28): 27-34 pp

Economy metabolism

- Ferrão, P. (2002). Economy's metabolism: Indicators, scales, and technology. 6th International Conference on Technology Policy and Innovation, Kansai, Japan, 12-15 August 2002.
- Canas, A., Ferrão, P. and Conceição, P. (2002) "A new environmental kuznets curve? Relationship between direct material input and income per capita: evidence from industrialized countries". Paper accepted for publication in the journal: *Ecological Economics*.

Electric and electronic equipments

- Giacomucci, M. Graziolo, P. Ferrão and A. Caldeira Pires (2002) "Environmental assessment in the electromechanical industry", in: *Knowledge for the Inclusive Development*, pp. 465-476. Eds. P. Conceição, D. Gibson, M. Heitor and F. Veloso, Quorum Books.

Packaging

- Ribeiro, P. (2002). Embalagens de Bens Alimentares: contributos para a definição de políticas eco-eficientes em Portugal. Dissertação para a obtenção do Grau de Mestre em Engenharia e Gestão de Tecnologia, Departamento de Engenharia Mecânica, Instituto Superior Técnico. [In Portuguese]
- Silva, P. (2002). Inovação ambiental na gestão de embalagens de bebidas em Portugal, Dissertação para a obtenção do Grau de Mestre em Engenharia e Gestão de Tecnologia, Departamento de Engenharia Mecânica, Instituto Superior Técnico. [In Portuguese]

3. 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, and now, a set of data taken from different sensors, during 2002, is available.

The following papers were developed in this context:

- Fluxos de momento, massa e energia na camada limite atmosférica em montado de sobreiro. Mestre Abel Rodrigues, PhD in Environmental Engineering, IST, Junho de 2002.
- Filling the gaps in time series from a farm meteorological station, Palma, J., Domingos, J., Pita, G., Sousa, T., VII congress of the European society for agronomy, Cordoba, Spain 15-18, July 2002.
- Full carbon balance in an eucalypt plantation in Portugal. [P7.23] The Carbon Balance of Forest Biomes, University of Southampton during the annual meeting of the SEB from the 1st to 4th of April 2003. J.S. Pereira (Instituto Superior de Agronomia, Lisbon); G. Pita, J. Silva (Instituto Superior de Técnico, Lisbon); A. Fabião, M. Carneiro, C. Nogueira (Instituto

4. Low-Power burning Systems

The ultimate goal towards the design and promoting the use of eco-combustion systems is to burn under lean condition, regarding the pollutant emission regulation while maximizing the global system efficiency. This concept is valid for a complete range of burning systems going from the domestic appliances to gas turbine combustors. However, under lean operating conditions there are self-sustained flame instabilities limiting the range of operations, induced either by the weakness of the lean flame stabilization process or shear layer instabilities, which are the main limitation for practical implementation of the concept. On the other hand, the burning system can benefit from those instabilities if they are controlled, because extended stability limits can be achieved, through hysteresis effects, as well as turbulent mixture can be enhanced, through large vortex motion. The work developed in this topic then focus on unsteady flows and active control schemes studies, with the following main publications:

Unsteady Flows

- LPP-Combustor Technology
- Comas O., Heitor M.V. and Shtork S.I. (2002), Experimental study of swirl flow structure in a model gas turbine combustor. Proc. 26th Siberian Thermophysical Seminar, June 17-19, 2002, Novosibirsk, Russia.
- Anacleto P.M., Fernandes E.C., Heitor M.V. and Shtork S.I. (2002) Characterization of strong swirling flows with precessing vortex core based on measurements of velocity and local pressure fluctuations. Proc. 11th Int. Symposium on Applications of Laser Techniques to Fluid Mechanics, Lisbon, July 8-11, 2002.
- C.E.C. Cala, E.C. Fernandes and M.V. Heitor (2002), Analysis of oscillating shear layer, Proc. 11th Int. Symposium on Applications of Laser Techniques to Fluid Mechanics, Lisbon, July 8-11, 2002.
- Anacleto P.M., Fernandes E.C., Heitor M.V., Shtork S.I. (2002) Precessing vortex core characteristics in a model lean premixed combustor. Accepted for publication in "Combustion Science and Technology".
- Fernandes E.C., Heitor M.V., Shtork S.I. (2002) On the dynamics of swirling recirculating flow with precessing vortex core. Submitted to "Experiments in Fluids".

Liquid Film Instabilities

- V. Sivasdas*, E.C. Fernandes and M.V. Heitor (2002) Acoustically excited air-assisted liquid sheets. Accepted for publication in Experiments in Fluids
- E. C. Fernandes*, F. Maçarico, D. J. Santos, (2002), An experimental study of a thin film flow with a planar hydraulic jump. Submitted to Experimental in Fluids

Domestic Burning Systems

- Sérgio Almeida (2002), Estudo de um fogão industrial, Graduation Project, IST-DEM-SS
- Vanda Gerales (2002), O efeito de introdução de oslicações na linha de combustível no desempenho energético de um fogão doméstico, Graduation Project, IST-DEM-SS

Active Control

- Luis Miguel Pina (2002) "Controlo Activo de Instabilidades", Graduation Project, IST-DEM-SS
- Gustavo Carneiro Brito, (2002), "Estratégia Predictiva para o Controlo Acústico de uma Câmara de Combustão", Graduation Project, IST-DEM-SS

5. Technical Change and Systems of Innovation

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.

Main publications:

Books:

- P. Conceição, M. V. Heitor, B.-A. Lundvall (eds.), (2003, forthcoming), *Innovation, Competence Building, and Social Cohesion in Europe- Towards a Learning Society*, London: Edward Elgar.
- P. Conceição, D. Gibson, M. V. Heitor, G. Sirilli, F. Veloso (eds.), (2002), *Knowledge for Inclusive Development*. Westport and London: Quorum Books.
- J.M.B. Brito, M. Heitor, M.F. Rollo (eds), (2002), “*Engenho e obra: uma abordagem á história da engenharia em Portugal no seculo XX*”, Lisboa: Dom Quixote

Papers in Books and refereed journals:

- Conceição, P. and Heitor, M. (2003, forthcoming). “Systems of innovation and competence building across diversity: Learning from the Portuguese path in the European context,” in Larisa V. Shavinina (Ed.). In “*International Handbook on Innovation*”, Elsevier
- P. Conceição, M. V. Heitor (2002), “Knowledge Interaction Towards Inclusive Learning - Promoting Systems of Innovation and Competence Building”, *Technological Forecasting and Social Change*, 69(7), pp.641-651.
- P. Conceição, D. Hammil, P. Pinheiro (2002), “Innovative Science and Technology Commercialization Strategies at 3M: A Case Study,” *Journal of Engineering and Technology Management*, 19(1): 25-38.
- P. Conceição, M. V. Heitor (2002), “Knowledge Interaction Towards Inclusive Learning - Promoting Systems of Innovation and Competence Building”, *Technological Forecasting and Social Change*, 69(7):641-651.
- Carneiro, R. and Conceição, P. (2002), “Beyond Formal Education: Learning-by-Doing, ICT Adoption and the Competitiveness of a Traditional Portuguese Sector,” *European Journal of Education*, 37(3), pp.263-280.
- R Baptista (2002), “Productivity and the Density of Local Clusters”, in “*Innovation Clusters and Inter-regional Competition*”, Johannes Bröker, Dirk Dohse and Rüdiger Soltwedel (ed.s), The Series in Advances in Spatial Economics, Springer Verlag Publishers.
- P. Conceição, James K. Galbraith (2002), “Technological Intensity and Inter-sectoral Dynamics of Inequality: Evidence from the OECD, 1970-1990,” *International Journal of Technology, Policy and Management*, 2(3), pp315-337.
- P. Conceição, and M. V. Heitor (2002), “University-based entrepreneurship and economic development: A learning-centred model”, *International Journal of Technology, Policy and Management*, 2(3), pp220-239.