Applied Dynamics

José Antunes

The activities at Applied Dynamics Laboratory (ADL) are devoted to research in nuclear engineering, with an emphasis in the vibratory and acoustic behaviour of mechanical components. Our group started in 1986, with the following objectives:

- Develop theoretical methods, computer tools and experimental techniques, to solve structural problems in nuclear power station components;

- Use this state-of-the-art know-how, in order to solve structural problems arising in Portuguese power plants and other industrial facilities.

The first objective has been pursued through extensive international collaboration with our main scientific partner - the French Commissariat à l'Energie Atomique (CEA) / Département de Mécanique et Technologie (DMT). More than one decade of fruitful collaboration is attested by a significant number of published results. Important problems have been solved, such as nonlinear vibrations in steam-generators, flow-induced vibrations of nuclear fuel and stability problems in rotating machinery. Furthermore, new identification techniques have been developed and applied with success to nonlinear dynamical systems.

The second objective has been pursued by starting in 1990 a series of projects with (and for) the Portuguese power supplier Electricidade de Portugal / Companhia Portuguesa de Produção de Electricidade (EDP/CPPE), stemming from actual structural problems in power plants (Sines, Setúbal): These projects enabled us to model and solve vibratory problems arising in rotating machinery, vibro-acoustical problems in boilers and heat-exchangers, as well as structural identification problems. Several computer codes have been developed in connection with these projects.

In recent years we also started research projects of more fundamental nature, mainly funded through the Praxis XXI and Sapiens research programmes. These projects have been developed in partnership with several Portuguese institutions (Faculdade de Ciências de Lisboa, Instituto Politécnico do Porto, Instituto Politécnico de Setúbal, Instituto Superior Técnico, Universidade Nova de Lisboa), as well as the Université de Paris and Southampton University.

The Applied Dynamics team is mainly concerned with the following scientific fields: structural dynamics, flow¬induced vibrations, nonlinear dynamics, vibro-acoustics, experimental methods, signal processing and system identification. As a spin-off from our research activities, teaching has been actively pursued on structural dynamics and acoustics - ranging from university level courses in Portugal (Coimbra, Lisbon) to several post¬graduation short courses abroad (Paris, Dublin). Also, student training and several university thesis (MSc and PhD) have been successfully supervised, for both Portuguese and foreign students.

Among the above-mentioned scientific fields one should stress those features which give our group a distinct profile from others working in structural dynamics in Portugal. Those features are: (1) a proven expertise and output in flow-excited systems and nonlinear vibrations; (2) a complementary theoretical/experimental approach for every problem.

There are no nuclear power stations in Portugal. However, past experience has proved convincingly that the Applied Dynamics Laboratory can be an active contributor at international science level, as well as a versatile problem¬solving unit for domestic industrial partners. Therefore, the previously stated objectives remain our motivation and driving force. In spite of ADL exceedingly scarce permanent staff, we managed to attract a number of motivated students and scientific collaborators from other institutions, who are essential for our activities. Obviously, the active collaboration with other scientific partners, more than a strategic convenience, is for this laboratory a matter of survival.

Many of the research projects pursued at ADL have based on research contracts. The main results and publications stemming from our research are summarised in the following pages. From these results, we highlight the development of a semi-analytical method for predicting the nonlinear vibrations of nuclear spent racks, accounting for the flow-coupling effects of the storage pool. In contrast to current finite-element approaches, this method enables a realistic accounting of nonlinear and dissipative fluid effects, which are essential when the system is subjected to strong seismic excitations. In a different field, we have developed techniques to integrate the complex dynamics of a main supporting structure when a given substructure is excited, in particular by friction. These techniques, developed in the context of fundamental physics, may be adapted to model industrial problems subjected to nonlinear interactions, when part of the system may only be characterized in terms of experimental data. Other interesting results stem from our research on the optimization of dynamical systems. We built and performed the experimental validation on six different specimens of optimized vibratory and acoustic systems, consistently achieving results in close agreement with predictions. We also pursued our fruitful collaboration with the group of Structural Geology at FCL, exploring a computational model previously developed.

A PhD thesis has been concluded and submitted at UNL, while another PhD is at the final stage.

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Research Team

Researchers

- J. ANTUNES, Principal Researcher

External Collaborators

- L. HENRIQUE (30%), Adj. Professor - IPP, Porto
- O. INÁCIO (30%), Adj. Professor - IPP, Porto
- M. MOREIRA (30%), Adj. Professor - IPS, Setúbal
- M. PAULINO (20%), Adj. Professor - IPL, Lisboa
- R. SAMPAIO (10%), Adj. Professor - ENIDH, Lisboa

Technical Personnel

- A. ANASTÁCIO, Technician

Funding (€)

Research Projects:	15 000
Services:	0
Total:	**15 000**

Publications

Books:	0
Journals:	2 and 1 in press
Proceedings:	6
Conf. Communications:	2
Other publications:	2
Theses: PhD	1