
APPLIED DYNAMICS LABORATORY

Annual Activity Report 2013

UNIT: Reactors and Nuclear Safety

TEAM

Name	Category	R&D (%)
José Vieira Antunes	Principal Researcher	100%
Miguel Carvalho	FCT Ph.D. student	100%
Vincent Debut	Ph.D. collaborator	40%
Miguel Marques	Student collaborator	20%

OBJECTIVES

Activities at Applied Dynamics Laboratory (ADL) are mainly devoted to research in nuclear engineering, with an emphasis on the vibratory and acoustic behaviour of mechanical components in nuclear facilities. On the other hand, research projects connected with dynamical problems of more fundamental nature are also pursued, in order to develop modelling and system identification methods and computational tools relevant for the problems addressed. The specific know-how which demarks ADL from other research laboratories in the country is our proven experience in: (a) Flow-induced vibrations, (b) Nonlinear dynamics due to localized impacts.

The objectives of the group for 2013 are connected with the research projects of ADL pursued under contract, namely: (1) Flow excited steam generator tubes and fuel rods (CEA contract, France), (2) Dynamical characterization and tuning of the Mafra carillons (FCT contract), (3) Dynamical modelling of the Portuguese guitar (FCT contract) and (4) Dynamics of Rotating Machinery (FCT Transnational cooperation Portugal/Tunisia). Under this framework, the scientific objectives for 2013 were:

- (1) To develop and refine new methods for accurate simulation and experimental identification of the flow turbulence excitation of tubular bundles;
- (2) To perform a full experimental characterization of the current tuning state of the Mafra carillons and extract objective quantifiers from such data;
- (3) To develop and refine models for the vibrations of the guitar strings coupled to an instrument body;
- (4) To develop techniques for accurate dynamical modelling of complex rotating machinery.

MAIN ACHIEVEMENTS

(1) Flow excited steam generator tubes and fuel rods:

This project is pursued under contract with the *French Commissariat à l'Energie Atomique et aux Energies Alternatives* (CEA/Saclay), in order to devise sophisticated identification methods to extract information on the spatial distribution and on the spectral content of flow turbulence excitations within the tube bundles of nuclear facilities. During 2013, in collaboration with colleagues from CEA, we further developed and applied to multi-supported fuel bundles a general strategy to identify the turbulence excitation from measurements of nuclear rod response vibrations, a quite delicate inverse problem. The developed approach is based on the extraction of the modal responses from a set of measured vibrations along the tube, using the SOBI blind identification method. Then, by suitable inversion techniques, the modal excitations are estimated, from which it was possible to infer the excitation turbulence spectrum and the flow velocity profile.

Typical results are illustrated in Fig. 1, where the turbulence excitation spectrum (c) and the flow velocity profile (d) have been identified from a set of vibratory response measurements shown in (a) and (b). Notice however that these quite satisfactory results were based on simulated data. However, because of the sensitivity of inverse problems to the measurement noise and modelling uncertainties, further difficulties must still be solved in order to apply the identification strategy to actual experiments. This effort will be pursued in 2014.

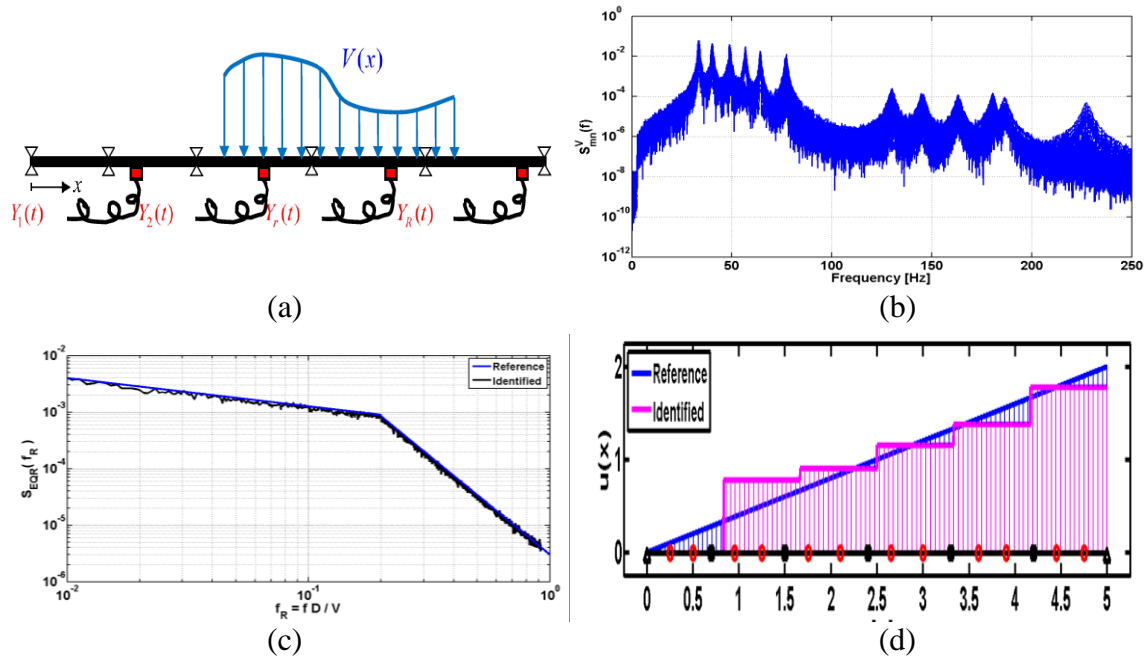


Figure 1: Illustration of identified results based on simulated data. (a) Typical response measurement setup; (b) Set of superposed measured response spectra; (c) Reference and identified turbulence excitation spectrum; (d) Reference and identified flow velocity profile.

Another important output from this work was the development of original refined methods for the estimation of unmeasured cross-spectra and cross-correlation functions from a limited set of measured data, in order to reconstruct incomplete measurement matrices, as illustrated in Fig. 2. The four data reconstruction techniques developed in 2013 to address difficulties in this project can potentially be also used within a large body of other identification problem fields.

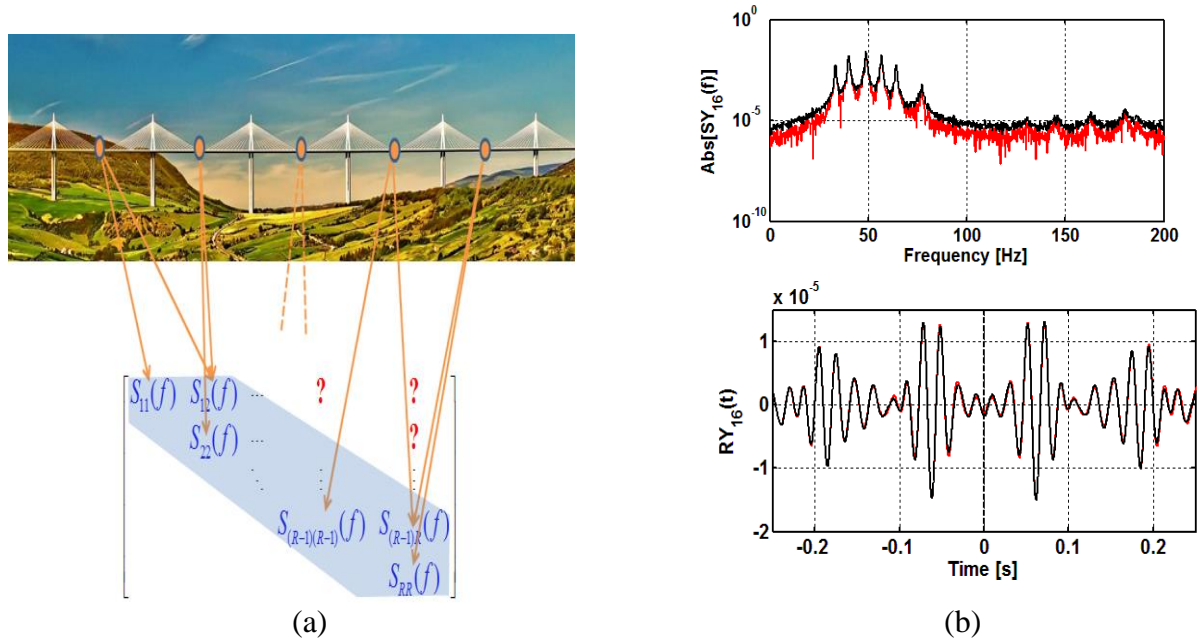


Figure 2: Illustration of estimation of non-measured cross-spectra and cross-correlation functions from a limited set of measured data. (a) The measurement matrix reconstruction problem; (b) Reference (black) and estimated (red) cross-spectrum and cross-correlation functions.

From the described work, four papers were published in international conferences and three papers have been accepted for publication in international journals. Most notably, one of these papers was awarded the international *Elsevier prize - Mechanical Systems and Signal Processing*, as best paper of the CMMN02013 Conference.

(2) Dynamical characterization and tuning of the Mafra carillons:

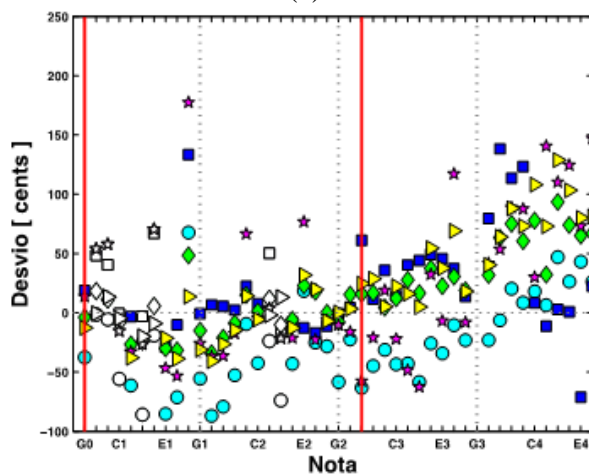
This work is aimed at analysing the tuning of the Mafra carillons bells, which form the largest surviving 18th century carillons in Europe. It is part of a multidisciplinary FCT research project in partnership with the Music Department from the Universidade Nova de Lisboa. In the framework of this project we previously developed suitable multi-reference identification techniques to extract the bell vibration modes from experiments. Then we have devised optimal strategies to infer their tuning status and the tuning errors with respect to historical musical tempered scales.



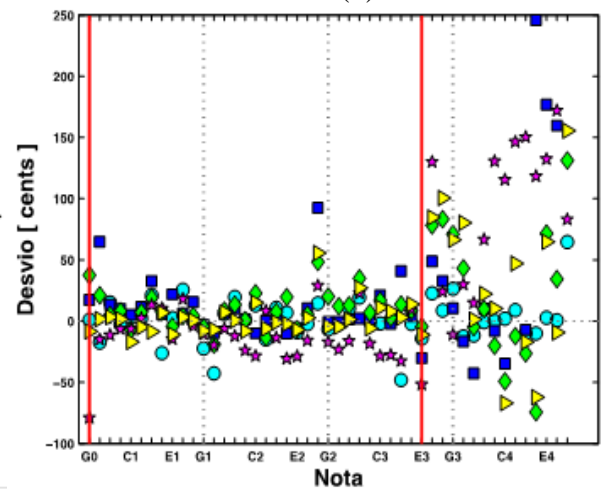
(a)



(b)



(c)



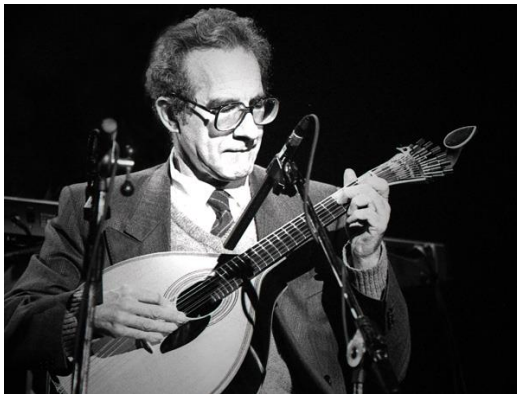
(d)

Figure 3: Illustration of the tuning errors, for several modes of the various bells, between the Levache carillon (North tower) and the Witlockx carillon (South tower) of the Mafra palace. (a,b) The Mafra carillons; (c) Levache tuning results; (d) Witlockx tuning results.

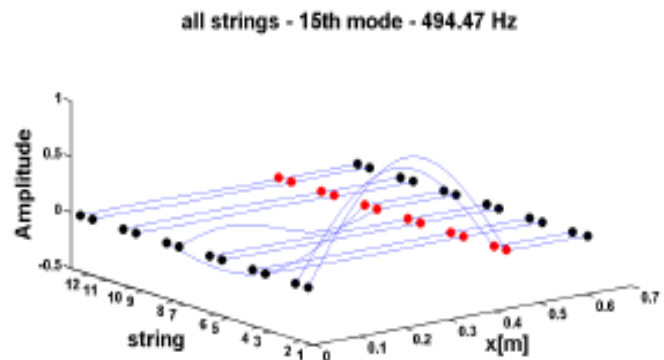
These techniques have now been applied to fully analyse the bells of the two Mafra carillons. It should be noted that these pertain to different builders - N. Levache from Liège and W. Witlockx from Antwerp - of dissimilar reputation. We have analysed the tuning state and tuning reference frequency of both carillons, using the developed optimization approach, with respect to several musical tempered scales. As illustrated in Fig. 3, the results obtained demonstrate that all aspects of tuning in the Witlockx carillon are significantly better than in the Levache carillon, with a greater control of the frequencies of the various bell modes. Nevertheless, even the better instrument displays tuning dispersion errors which are larger than the small differences between Baroque temperaments, thus preventing a positive identification of their target temperament. This work already led to a MSc thesis presented at UNL, while three papers have been published in the proceedings of peer-reviewed international conferences. A paper was submitted for publication in an international journal.

(3) *Dynamical modeling of the Portuguese guitar:*

In the framework of this new FCT funded project, we have pursued modelling the complex dynamics of the Portuguese guitar. During 2013 we have extended our previous model on the coupling between the strings and the instrument body, using modal methods. We thus produced a 3D theoretical model of the coupled strings/soundboard, from which the coupled modes and time-domain transient responses have been obtained. Particularly interesting, are the results obtained which show the energy transfer between the guitar sub-systems. Fig. 4 illustrates one of the many string/body coupled modes, computed from the numerical model of a simplified guitar. This work led to two papers published in the proceedings of peer-reviewed international conferences. A paper was submitted for publication in an international journal.



(a)



(b)

Figure 4: Illustration of the string/body coupled dynamics of a simplified guitar model. (a) Portuguese guitar played by Carlos Paredes; (b) A complex mode of the 12 strings coupled by the soundboard.

(4) *Dynamics of Rotating Machinery:*

This new collaborative project with the ENIS-University of Sfax, in the context of the Bilateral Research Agreement Portugal-Tunisia (2013-2014), aims ultimately the development of innovative techniques for the dynamical balancing of multi-supported flexible rotors, using a minimum of experimentally obtained information. During 2013 we have been mostly concerned with devising a general framework for this research and the first stage of the project - the analytical and numerical techniques for modeling the vibratory responses of a complex rotor as a function of the spinning velocity. Development of a computer program for the implementation of these techniques is currently under way. This work will be amplified in 2014 through the three-month stage at ADL of a Tunisian student from ENIS, which should later start a PhD thesis on modeling and balancing of rotating machinery.

RELEVANT PAPERS

- J. Antunes, L. Borsoi, X. Delaune, P. Piteau, “Simple relations for estimating the unknown functions of incomplete experimental spectral and correlation response matrices”. *3rd International Conference on Condition Monitoring of Machinery in Non-Stationary Operations (CMMN02013)*, Ferrara, Italy, 8-10 May 2013. Published in the Proceedings book (Eds. Dalpiaz, G., Rubini, R., D’Elia, G., Cocconcelli, M., Chaari, F., Zimroz, R., Bartelmus, W., Haddar, M.), Springer (2014), ISBN 978-3-642-39347-1.
- J. Antunes, P. Piteau, X. Delaune, L. Borsoi, “Spatio-frequential characterization of non-uniform turbulence excitations from the vibratory responses using inverse techniques: Part 1 - Extraction of the modal responses from the vibratory measurements; Part 2 - Extraction of the modal responses from the vibratory measurements”. *22nd Conference on Structural Mechanics in Reactor Technology (SMIRT-22)*, San Francisco, USA, 18-23 August, 2013.
- J. Antunes, V. Debut, M. Carvalho, “Identification of the unconstrained modes of 3D axisymmetric structures from measurements under constraining support conditions”. *5th International Conference on Design and Modelling of Mechanical Systems (CMSM2013)*, Djerba, Tunisia, 25-27 March 2013.

- M. Marques, J. Antunes, V. Debut, “Coupled Modes and Time-Domain Simulations of a Twelve-String Guitar with a Movable Bridge”. *Stockholm Music Acoustics Conference (SMAC 2013)*, Stockholm, Sweden, 30 July-3 August 2013.
- V. Debut, M. Carvalho, J. Antunes, “An objective approach for assessing the tuning properties of historical carillons”. *Stockholm Music Acoustics Conference (SMAC 2013)*, Stockholm, Sweden, 30 July-3 August 2013.

FUNDS

Project/Service	Reference	Timeframe	2013
<i>IVECO-2: Modeling and identification of flow turbulence excitations in nuclear fuel rods</i>	ADIST AD/2013/87 CEA 4000533537/P5B61	01/10/2012 30/09/2013	12000 €
<i>The Mafra carillons: Development of Advanced Methods in Music Acoustics for Tuning and Restoration</i>	FCT PTDC/EAT- MMU/104255/2008	01/04/2010 31/03/2013	0 € ⁽¹⁾ (1) The project expenses are currently under analysis by FCT for reimbursement
<i>Improvement of the acoustical performance of the Portuguese Guitar</i>	FCT PTDC/EMS- SIS/3255/2012	03/06/2013 02/06/2015	0 € ⁽²⁾ (2) Beginning of the project funding in 2014
<i>Dynamics of Rotating Machinery</i>	FCT Bilateral Research Agreement Portugal- Tunisia	01/01/2013 31/12/2014	2400 €

INTERNATIONALIZATION

- By far, the main international scientific partner of ADL is the French Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA, Saclay, France), Département de Modélisation des Systèmes et Structures, Laboratoire d'Études de Dynamique. With this institution ADL developed more than 25 years of fruitful collaboration, attested by a significant number of published results and more than twenty research contracts since 1988. Important problems have been solved, such as nonlinear vibrations in steam-generators, flow-induced vibrations of nuclear fuel and stability problems in rotating machinery. Two ASME prizes were awarded in the past to LDA publications from our research with CEA. In recent years, we focused on new identification techniques, applied with success to nonlinear dynamical systems, through the research contracts VITAMINE, TGV-ICE and the currently pursued, IVECO-1 and IVECO-2 (2011-2013), all funded by CEA. One of the papers published during 2013 within the framework of this collaboration was awarded the international *Elsevier prize - Mechanical Systems and Signal Processing*, as best paper of the CMMN02013 Conference.
- As a result of our long standing scientific collaboration with France, ADL has developed contacts with several French laboratories and universities in the field of nonlinear dynamics and acoustics, connected with problems of more fundamental nature. As a result, the ADL head researcher is often invited for lecturing at scientific meetings and short courses in France, as well as for PhD and Habilitation juries. He is member of the Scientific Council of LAMSID – Laboratoire de Mécanique des Structures Industrielles Durables (UMR 2832), partenariat EDF/CNRS/CEA (Clamart, France) and committee member of the French Agence d'Evaluation de la Recherche et de l'Enseignement Supérieur (AERES) for the scientific evaluation of IRCAM (UMR 9912), attached to Centre Pompidou for Contemporary Art, Paris, France.
- During 2013 the scientific collaboration between ADL and the Ecole Nationale d'Ingénieurs de Sfax (ENIS), within the Bilateral Research Agreement Portugal-Tunisia, was strengthened in a research project on the Dynamics of Rotating Machinery. A visit of Profs. M. Haddar and F. Chaari took place on 15-23 December 2013 and a stage at ADL from an ENIS student is scheduled for 2014, in order to start a Ph.D. on the topic of this collaboration.

- The coordinator of ADL was in 2013 reporter jury member for the PhD “Surveillance et diagnostic des ventilateurs par methode acoustique”, École Nationale d’Ingénieurs de Sfax - Université de Sfax, Tunisie, 6 November 2013.
- Internationalization is also attested by frequent invitations for scientific committees of international conferences and session organization. In 2013, the coordinator of ADL was a member of the Scientific Committee of the 3rd International Conference on Condition Monitoring of Machinery in Non-Stationary Operations (CMMN02013), Ferrara, Italy, 8-10 May 2013, as well as of the Scientific Committee of the 5th International Conference on Design and Modelling of Mechanical Systems (CMSM2013), Djerba, Tunisia, 25-27 March 2013.
- In 2013 an international Small or medium-scale focused research project (STREP) was built and submitted, involving the Trinity College Dublin (TCD, Ireland), IST-CTN/URSN-ADL (Portugal) and the Royal Institute of Technology (KTH, Sweden). Unfortunately this project submission was not funded, however the contacts thus established remain for future calls.

RESEARCHERS TEAM

NAME: José Manuel Vieira Antunes

CATEGORY: Principal Researcher

IST-ID: 1738

ACTIVITIES

N°	Activity Description	R&D (%)
1	Modelling and identification of flow turbulence excitations in nuclear fuel rods: Project IVECO-2/CEA-4000533537/P5B61	30
2	Analysis of the tuning of the Mafra Carillons Bells: Project PTDC/EAT-MMU/104255/2008	20
3	Dynamics of coupled string-body interaction systems: Project PTDC/FIS/103306/2008	20
4	Modelling, optimal balancing and experimental validation of the dynamics of a multi-supported rotor: Project of Transnational Cooperation Portugal (IST-CTN)/Tunisia (ENIS)	10
5	Dynamical behaviour of articulated pipes subjected to aspirating flows	15
6	Diagnostic of vibration problems in a prototype machine for olive tree harvesting	5
Total		100

WORK SUMMARY

N°	Work Summary and main Achievements
1	<p>Modelling and identification of flow turbulence excitations in nuclear fuel rods Project IVECO-2/CEA-4000533537/P5B61</p> <p>This work is being performed in the context of a research contract with the French Commissariat à l’Energie Atomique et aux Energies Alternatives, CEA/Saclay, with whom the Applied Dynamics Laboratory (ADL) has performed collaborative research, funded by CEA, for more than 25 years and through more than twenty research contracts. The main point of this project was to devise sophisticated identification methods in order to extract information on the spatial distribution and on the spectral content of flow turbulence excitations within the bundles of nuclear fuel rods. This topic is essential for the success of predictive analysis under flow induced vibration. During 2013, in collaboration with colleagues from CEA (researchers L. Borsoi, X. Delaune and P. Piteau), we developed our general strategy to identify the turbulence excitation from measurements of the rod response vibrations, a very delicate inverse problem. In particular, three original methods have been developed for reconstructing the full spectral and correlation measurement matrices from</p>

	<p>partial measurements. From our collaborative efforts, three journal papers have been accepted for publication and four papers were published in the proceedings of peer-reviewed international conferences. One of these papers was awarded the international <i>Elsevier prize - Mechanical Systems and Signal Processing</i>, as best paper of the CMMN02013 Conference.</p>
2	<p>Analysis of the tuning of the Mafra Carillons Bells Project PTDC/EAT-MMU/104255/2008</p> <p>This work is aimed at analysing the tuning of the Mafra carillons bells, which form the largest surviving 18th century carillons in Europe. It is part of a multidisciplinary FCT, research project in partnership with the Music Department from the Universidade Nova de Lisbon. My participation in this project, beyond the coordination of the IST/CTN tasks, has been to perform with Dr. V. Debut and our PhD student M. Carvalho the physical and mathematical analysis of the bells vibro-acoustic behaviour, as well as devising optimal strategies to infer the carillons tuning status and tuning errors, with respect to current historical knowledge on XVIIIth Century tempered scales. Our previous work in this project was pursued during 2013, by refining our techniques for bell modelling and tuning characterization. From this work, three papers have been published in the proceedings of peer-reviewed international conferences and a paper was submitted for publication in an international journal.</p>
3	<p>Dynamics of coupled string-body interaction systems Project PTDC/FIS/103306/2008</p> <p>This activity has been pursued with Dr. V. Debut and our research student M. Marques, in the context of a FCT project on the dynamics of string instruments. During 2013 we have been extending our previous model on the coupling between the strings and the instrument body, using modal methods. We thus produced a 3D theoretical model of the coupled strings/soundboard, from which the coupled modes and time-domain transient responses have been obtained. Particularly interesting, are the results obtained which show the energy transfer between the guitar sub-systems. From this work two papers have been published in the proceedings of peer-reviewed international conferences and a paper was submitted for publication in an international journal.</p>
4	<p>Modelling, optimal balancing and experimental validation of the dynamics of a multi-supported rotor Project of Transnational Cooperation Portugal (IST-CTN)/Tunisia (ENIS)</p> <p>Our group has been working since long on the dynamics of rotating machinery. This bilateral FCT funded project follows a previous one led by Dr. V. Debut and is concerned about rotor balancing. The aim is to develop theoretical methods for the optimized dynamical balancing of multi-supported flexible rotors, using a minimum of experimental information. During 2013 I went twice to ENIS (Tunisia) for technical discussions on the project and a seminar. A general framework for this research was established in detail between the project partners and a PhD on the subject will soon be launched.</p>
5	<p>Dynamical behaviour of articulated pipes subjected to aspirating flows</p> <p>The instability of flow-excited pipes is an important issue for industrial facilities, but also as paradigmatic problem on coupled dynamics. Although flow-excited pipes have been thoroughly studied for many years and are well understood, the same cannot be stated concerning aspirating pipes, whose dynamical behaviour - once questioned in a book by Feynman - is still the subject of a large controversy. In order to contribute to the understanding of this problem, with Dr. V. Debut and the general guidance of French colleague Prof. F. Axisa (CEA, ENSTA), we performed an extensive series of static and dynamical experiments on articulated pipes subjected to aspirating flow. These interesting results are currently being analysed and compared with several possible theoretical models. At a more developed stage, they will certainly contribute to a better understanding of this fascinating problem.</p>
6	<p>Diagnostic of vibration problems in a prototype machine for olive tree harvesting</p> <p>Following a request by colleagues from Evora University - Group of Agriculture Machinery - we have been recently involved in the diagnostic of vibration problems experienced on their prototype machine for olive tree harvesting. Actually, their equipment displays undue severe vibrations and fatigue failures, for some operating conditions, which are unacceptable. With Dr. V. Debut, we have thus performed several field-tests on their</p>

equipment, as well as some modelling work, in order to diagnose the problem and produce recommendations for increasing the machine fiability.

PUBLICATIONS

Journals papers:

- J. Antunes, L. Borsoi, X. Delaune, P. Piteau, “Identification of random excitation fields from vibratory responses with application to multi-supported tubes excited by flow turbulence”. *ASME Journal of Pressure Vessel Technology* (in print).
- I. Politopoulos, Ph. Piteau, J. Antunes, L. Borsoi, “Applications of hybrid time-frequency methods in nonlinear structural dynamics”. *Engineering Structures* (in print).
- F. Marques, N. Mandal, R. Tabora, J. Antunes, S. Bose, “The behaviour of deformable and non-deformable inclusions in viscous flow”. *Earth-Science Reviews* (in print).
- J. Antunes, L. Borsoi, X. Delaune, P. Piteau, “Techniques for Estimating the Unknown Functions of Incomplete Experimental Spectral and Correlation Response Matrices”. *Mechanical Systems and Signal Processing* (accepted for publication).

Papers in peer-reviewed conference proceedings:

- M. Marques, J. Antunes, V. Debut, “Guitar strings loaded with localized masses”. *11th International Conference on Vibration Problems (ICOVP-2013)*, Lisboa, Portugal, 9-12 September, 2013.
- J. Antunes, P. Piteau, X. Delaune, L. Borsoi, “Spatio-frequential characterization of non-uniform turbulence excitations from the vibratory responses using inverse techniques: Part 1 - Extraction of the modal responses from the vibratory measurements”. *22nd Conference on Structural Mechanics in Reactor Technology (SMIRT-22)*, San Francisco, USA, 18-23 August, 2013.
- J. Antunes, P. Piteau, X. Delaune, L. Borsoi, “Spatio-frequential characterization of non-uniform turbulence excitations from the vibratory responses using inverse techniques: Part 2 - Extraction of the modal responses from the vibratory measurements”. *22nd Conference on Structural Mechanics in Reactor Technology (SMIRT-22)*, San Francisco, USA, 18-23 August, 2013.
- M. Marques, J. Antunes, V. Debut, “Coupled Modes and Time-Domain Simulations of a Twelve-String Guitar with a Movable Bridge”. *Stockholm Music Acoustics Conference (SMAC 2013)*, Stockholm, Sweden, 30 July-3 August 2013.
- V. Debut, M. Carvalho, J. Antunes, “A new method for the identification of the original modes of damped three-dimensional axi-symmetric structures subjected to constraining boundary conditions”. *Stockholm Music Acoustics Conference (SMAC 2013)*, Stockholm, Sweden, 30 July-3 August 2013.
- V. Debut, M. Carvalho, J. Antunes, “An objective approach for assessing the tuning properties of historical carillons”. *Stockholm Music Acoustics Conference (SMAC 2013)*, Stockholm, Sweden, 30 July-3 August 2013.
- J. Antunes, L. Borsoi, X. Delaune, P. Piteau, “Identification of the turbulence force field excitation from a set of vibratory responses of a multi-supported tube”. *ASME 2013 Pressure Vessels and Piping Conference (PVP 2013)*, Paris, France, 14-18 July, 2013.
- J. Antunes, L. Borsoi, X. Delaune, P. Piteau, “Simple relations for estimating the unknown functions of incomplete experimental spectral and correlation response matrices”. *3rd International Conference on Condition Monitoring of Machinery in Non-Stationary Operations (CMMNO2013)*, Ferrara, Italy, 8-10 May 2013. Published in the Proceedings book (Eds. Dalpiaz, G., Rubini, R., D'Elia, G., Cocconcelli, M., Chaari, F., Zimroz, R., Bartelmus, W., Haddar, M.), Springer (2014), ISBN 978-3-642-39347-1.
- J. Antunes, V. Debut, M. Carvalho, “Identification of the unconstrained modes of 3D axisymmetric structures from measurements under constraining support conditions”. *5th International Conference on Design and Modelling of Mechanical Systems (CMSM2013)*, Djerba, Tunisia, 25-27 March 2013.

Scientific reports:

- J. Antunes, V. Debut, “Diagnóstico vibratório de uma máquina de apanha de azeitona desenvolvida pela Universidade de Évora”. *Report IST/CTN/LEN/NDA – Dez1 /1*.

- J. Antunes, X. Delaune, “VITAMINE 4 - Formulation et utilisation du programme pour le calcul dynamique des éléments combustibles”. *Report IST/CTN/URSN/LDA - Jun13/1*.

COMMUNICATIONS

- M. Carvalho, V. Debut, J. Antunes, “Some aspects on accessing the tuning of the Mafra carillons”. *Congresso de Organologia*, Évora, Portugal, 18-20 Abril 2013.
- J. Antunes, Opening address at *Colóquio "Símbolos de Bronze: Representação e tecnologia nos Carrilhões de Mafra"*, Biblioteca do Palácio Nacional de Mafra, 30 November 2013.
- J. Antunes, “Identification des forces de contact d'après un ensemble de mesures vibratoires par méthodes inverses”. Université de Sfax, Tunisie, 29 March 2013, Seminar.
- J. Antunes, “Vibrations excitées par la turbulence des écoulements”. Laboratoire de Mécanique et d'Acoustique (LMA), Centre CNRS de Marseille, France, 31 May 2013, Seminar.
- J. Antunes, V. Debut, M. carvalho, “An objective approach for assessing the tuning properties of historical carillons”. Laboratoire Lutheries-Acoustique-Musique (LAM), Institut Jean le Rond d'Alembert (CNRS UMR 7190), Université Pierre et Marie Curie (Paris 6), France, 14 October 2013, Seminar.
- J. Antunes, V. Debut, M. Carvalho, “Des carrillons et des cloches”. Commissariat à l’Energie Atomique, Centre d’Études de Saclay, France, 23 October 2013, Seminar.
- J. Antunes, “Méthodes pour la reconstruction de matrices de mesure incomplètes”. Université de Sfax, Tunisie, 7 November 2013, Seminar.

EDUCATION

- Co-supervision of the PhD student **Miguel Carvalho** at LDA on the vibro-acoustics and tuning of carillon bells, in the framework of the FCT project PTDC/EAT-MMU/104255/2008.
- Co-supervision of the research work of the MSc student **Elisa Costa** at LDA on the dynamics of guitar strings, in the framework of the FCT project PTDC/FIS/103306/2008.
- Co-supervision of the research student **Miguel Marques** at LDA on the dynamics of worn strings and also on the coupled dynamics of a string/plate, in the framework of the FCT project PTDC/FIS/103306/2008.
- Reporter jury member for the PhD thesis of **Majdi Abid**, “Surveillance et diagnostic des ventilateurs par methode acoustique”, École Nationale d’Ingénieurs de Sfax - Université de Sfax, Tunisie, 6 November 2013.
- Arguing jury member for the MSc thesis in Aerospace Engineering of **Miguel António Albuquerque da Silva Matos**, “Balancing and force identification in rotordynamics”, Instituto Superior Técnico, Portugal, 25 November 2013.

PROJECTS

- Research Contract Ref. CEA-4000533537/P5B61 with IST/ADIST, “*IVECO 2 - Modelling and identification of flow turbulence excitations in nuclear fuel rods*”, Commissariat à l’Energie Atomique et aux Energies Alternatives, Saclay, France.
- *The Mafra carillons: Development of Advanced Methods in Music Acoustics for Tuning and Restoration*. FCT project PTDC/EAT-MMU/104255/2008. Leading Institution: Universidade Nova de Lisboa/Faculdade de Ciências Sociais e Humanas. IST/CTN Coordinator: J. Antunes.
- *Dynamical Analysis and Improvements on the Portuguese Guitar Strings and String/Body Interaction*. FCT project PTDC/FIS/103306/2008. Leading Institution: Instituto Superior Técnico/Departamento de Engenharia Mecânica. IST/CTN Coordinator: J. Antunes.
- *Modelling, optimal balancing and experimental validation of the dynamics of a multi-supported rotor*, Scientific and Technology Cooperation Agreement between the Foundation for Science and Technology (FCT) of Portugal and the Ministry for Higher Education and Scientific Research of Tunisia for the period 2013-2014 (FCT process Ref. 441.00 Tunisia).
- *NANOparticle-filled MUSICAL instruments - NANOMUSIC*, Small or medium-scale focused research project (STREP) submitted by the Trinity College Dublin (TCD, Ireland, M. Ferreira, J.

Coleman, H. Rice), with IST-CTN (Portugal, J. Antunes) and the Royal Institute of Technology (KTH, Sweden, P. Göransson). Project submission not funded.

CONFERENCE ORGANIZATION /COMMITTEES

- M. Pereira dos Santos, J. Soeiro de Carvalho, J. Antunes, Colóquio "Símbolos de Bronze: Representação e tecnologia nos Carrilhões de Mafra", Biblioteca do Palácio Nacional de Mafra, 30 November 2013.
- Committee member of the French *Agence d'Evaluation de la Recherche et de l'Enseignement Supérieur (AERES)* for the scientific evaluation of *IRCAM (Institut de Recherche et Coordination Acoustique/Musique, attached to Centre Pompidou for Contemporary Art, Paris, France), Unité Mixte de Recherche (UMR 9912)*. The latest committee evaluation report was sent to AERES on 3rd January 2013.
- Member of the Cientific Council of *LAMSID – Laboratoire de Mécanique des Structures Industrielles Durables, Unité Mixte de Recherche (UMR 2832)*, partenariat EDF/CNRS/CEA, Clamart, France.
- Member of the Scientific Committee of the *3rd International Conference on Condition Monitoring of Machinery in Non-Stationary Operations (CMMN02013)*, Ferrara, Italy, 8-10 May 2013.
- Member of the Scientific Committee of the *5th International Conference on Design and Modelling of Mechanical Systems (CMSM2013)*, Djerba, Tunisia, 25-27 March 2013.

COLLABORATIONS

- M. Haddar, F. Chaari, Ecole Nationale d'Ingénieurs de Sfax (ENIS), 15-23 December 2013, Bilateral Research Agreement Portugal-Tunisia, Dynamics of Rotating Machinery.