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Job Description

Role Title:	Postdoctoral Research Fellow in Vibro acoustics
School / Dept:	School of Science Engineering and Environment
Reference:	MPF 1020
Grade:	Grade 7
Full or Part time:	Full time
Hours:	36.25
Reports to:	Project leads for xDEA project

University of Salford MANCHESTER

Role Purpose

Across many industries there is a need for accurate simulation of mid/high frequency vibro-acoustics. In recent years this need has been further fuelled by the rapid uptake of electric drives within the automotive and aerospace sectors (among others). But the current state-of-the-art is unable to suitably model the vibro-acoustic behaviour of complex engineering structures in the mid/high frequency regime.

The aim of xDEA is to develop advanced, directional, eXperimental characterisation methods that integrate with Dynamical Energy Analysis (DEA) [1] - a state-of-the-art mesh-based simulation tool - and unlock a new hybrid paradigm for mid-to-high frequency vibro-acoustic simulation.

This is a joint project between the University of Salford and the University of Nottingham, with a Research Fellow based at each institution. The work undertaken at Salford will focus primarily on developing new experimental techniques, whilst the work at Nottingham will focus on more theoretical aspects. Though, the two groups will work closely together throughout the duration of the project so there may be some cross-over.

This project is funded by the EPSRC and supported by industrial partners: Siemens, Jaguar Land Rover, BAE Systems, Qinetic, Airbus, and Hoare Lea.

As a Research Fellow on xDEA you will be expected to:

- Design and conduct vibro-acoustic experiments to obtain component characterisation data
- Develop novel experimental techniques using laser doppler vibrometry to characterise wave scattering in structures,
- Collaborate with colleagues at the University of Nottingham,
- Disseminate research through conference attendance and journal publications,
- Engage with industrial partners as part of case studies.

Applicants must have – or about to be awarded – a relevant PhD degree in acoustics, engineering, or physics (or a related discipline). To carry out the proposed research and deliver the expected research outcomes, the candidate will need to demonstrate knowledge and understanding of fundamentals of vibration and advanced measurement techniques. The candidate will be expected to disseminate their research both to academic peers and the general public.

The contract is fixed term for 36 months, ending on 31st July 2028.

The Salford's Acoustics Research Centre is one of the largest acoustics groups in Europe. The Acoustics Research Centre has state-of-the-art equipment and facilities to conduct vibroacoustic measurements and develop new acoustic metrology techniques.

The academic team includes Dr Joshua Meggitt (https://www.researchgate.net/profile/Joshua-Meggitt); an internationally recognised researcher in the field of Transfer Path Analysis and vibro-acoustics, and Dr Jonathan Hargreaves (https://www.researchgate.net/profile/Jonathan-Hargreaves), a renowned researcher with an excellent track record in computer simulation and material characterisation for acoustics.

[1] Tanner, G., 2009. Dynamical energy analysis—Determining wave energy distributions in vibro-acoustical structures in the high-frequency regime. *Journal of Sound and Vibration*, *320*(4-5), pp.1023-1038.

Some More Background

Limitations of Current Approaches - Simulation: Computational cost scaling with frequency and domain size limits conventional mesh-based methods (FEA/BEM) to small problems and/or low/mid frequencies. Whilst this has been sufficient for many years, e.g.\ for the analysis of combustion driven vehicles where low/mid frequency noise is dominant, the trend towards electrically driven vehicles has shifted the goal posts. Moreover, at high frequencies:

University of Salford MANCHESTER

- Typical junctions (rivets, spot welds, etc.) include damping effects at that are difficult to predict / have high uncertainties, and require a framework that includes experimental characterisation / validation.
- Small imperfections due to manufacturing tolerances lead to large changes in dynamic behaviour.

For these reasons *energy-based methods* provide the only meaningful route at high frequencies.

An established energy-based method is Statistical Energy Analysis (SEA). But it is not ideal because it is based on assumptions that are often not satisfied in practice, and its solutions provide insufficient detail.

Dynamical Energy Analysis (DEA) is a mesh-based simulation method that is a versatile tool for modelling the high frequency behavior of structures. It offers user-controllable spatial resolution and directional energy transport, overcoming many of SEA's limitations.

Limitations of Current Approaches - Measurement: Real world vibrational sources are complex machines that are often beyond the scope of numerical simulation. And, as already mentioned, junctions can have high uncertainties and do not readily succumb to numerical analysis. Hence, **experimental methods** provide the only practical approach for characterising the behavior of such components. This has long been recognised by industry, particularly the automotive sector, who have developed a suite of simulation methodologies based on experimental data, broadly known as **Transfer Path Analysis** (TPA).

The most appropriate TPA methodology for predicting the vibro-acoustic behaviour of complex engineering structures is *component-based TPA*. This involves breaking down the structure into components, each of which is characterised independently by its *frequency response functions* (FRFs) and *blocked forces* (for active components). The assembled structure is then recombined by numerical means.

Vision and Challenges: We will develop a framework that combines DEA with experimental measurements. This will make the hybrid approach more flexible and allow for much higher resolution including directional information compared to current methods. Compared to FEA / BEM, the approach will be far more efficient since DEA does not require sub-wavelength meshing.

This hybridisation of DEA to include experimental components (such as complex vibration sources) would remove many of the limitations of current hybrid models and provide a robust tool for the simulation of *mid/high frequency vibro-acoustics* with applications in a wide range of industries. This is of course not without its challenges…

One challenge we will address is how best to connect data from experiments with DEA. Being a directional energy method, it uses scattering matrices relating incoming and outgoing energy flows at interfaces, whereas the former uses point-wise mobility and impedance-based descriptions. Additionally, we will supplement accelerometer measurements will full-field measurement, such as scanning Laser Doppler Vibrometry (LDV), to capture the directional wave dynamics as they propagate. This will enable both validation of the hybrid xDEA model and allow characterisation of sources with distributed contact areas.

Principal Duties & Responsibilities

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- Conduct research following the project plan and produce deliverables according to set deadlines.
- Lead research, under the supervision of the PI and other co-Investigators.
- Collaborate closely with the PIs, co-Is and other members of the project team - including at the University of Nottingham - to progress and collaboratively develop the research.
- Report findings to and consult the project's industrial partners to allow them to understand progress and steer the project, thereby maximising its impact.
- Disseminate research outputs both at peer-reviewed journals and conferences and to external organisations such as industry, public sector, charity and local community groups.
- Participate in ongoing research activities in collaboration with the PI, co-Is and other member of the research team.
- Respect the highly confidential nature of the material and ensure confidentiality.

Generic Duties

- Perform any other duties appropriate to the grade as may be required by the Head of School/Head of Division etc.
- Comply with the personal health and safety responsibilities specified in the University Health and Safety policy.
- To engage with the University's commitment to put our students first and deliver services which are customer orientated, represent value for money and contribute to the financial and environmental sustainability of the University when undertaking all duties and aspects of the role.
- Promote equality and diversity for students and staff and sustain an inclusive and supportive study and work environment in accordance with University policy.

This role detail is a guide to the work you will initially be required to undertake. It may be changed from time to time to meet changing circumstances. It does not form part of your Contract of Employment.

Person specification follows on next page

Person Specification

The successful candidate should demonstrate the following, which are 'Essential' (E) or 'Desirable' (D), and will be assessed by Application Form (A), Interview (I), Presentation (P), or Test (T), as indicated.

Qualifications

1. Hold a Degree or Masters in Acoustics, Engineering, or Physics (E) (A)
2. Hold (or be about to get) a PhD in Acoustics, Engineering or related discipline (E) (A)

Background and Experience

1. Conducting high-quality research in vibroacoustics or related subject area (E) (A) (I) (P)
2. Conducting experimental measurement in acoustics or a related field. (E) (A) (I) (P)
3. Developing data analysis / signal processing code (E) (A) (I) (P)
4. Publishing research in peer-reviewed journals (D) (A) (I)
5. Preparing codebases and datasets for public dissemination (D) (A) (I)

Knowledge

1. Measurement and modelling of vibroacoustic systems, e.g. beams / plates (E) (A) (I) (P)
2. Programming & data handling applicable to vibroacoustics (E) (A) (I) (P)
3. Transfer Path Analysis (D) (A) (I) (P)

Skills and Competencies

1. Proficiency in written and spoken English and excellent communication skills. (E) (A) (I)
2. Ability to present information clearly and conduct in-depth technical discussions with colleagues and project partners, and to present information accessibly in lay terms for public or stakeholder engagement. Ability to work efficiently and courteously in teams and liaise professionally with project partners (E) (A) (I) (P)
3. Ability to work under pressure, to prioritise and deliver according to set timescales and meet deadlines while managing multiple tasks. (E) (A) (I)
4. Ability to be proactive and lead research (D) (A) (I)

5. Willingness to learn new methods and techniques and expand their own research area (D) (A) (I)