VIRTUAL ASSEMBLIES AND THEIR USE IN THE PREDICTION OF VIBRO-ACOUSTIC RESPONSES

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1 INTRODUCTION

A drive towards leaner engineering has seen the use of physical prototypes become a limiting factor in the development of new products. Consequently, alternative prototyping methods are of interest. With their ability to reduced cost, time to market and optimize products to higher levels of performance and reliability, virtual methods are generally considered the way forward. Methods for virtual prototyping with respect to visual design and engineering (i.e CAD and CAE) are particularly well developed. Unfortunately, the same cannot be said in the realm of acoustics. Although numerical methods such as FEA and BEM are able to predict, with some accuracy, the passive properties of an assembly, they lack the ability to confidently model the complex behaviour of vibro-acoustic source mechanisms. Consequently, the adoption of any virtual acoustic prototyping (VAP) methodology will require some element of experimental work. While attempts have been made at establishing an experimentally based VAP framework[1], lack of measurement protocols and clear guidelines has seen its adoption within industry hindered. It is therefore the aim of this paper to introduce a set of methodologies that together provide the tools required to construct virtual assemblies for use in the prediction of vibro-acoustic quantities. The aims of this paper may be more specifically stated as:

1 Introduce an independent characterisation method for sources of structure-borne sound.
2 Recap the classical impedance summation approach for dynamic substructuring.
3 Introduce a novel method for determining the independent transfer properties of resilient coupling elements.
4 Provide an experimental case study utilising the above methodologies.

2 SOURCE CHARACTERISATION: BLOCKED FORCE METHOD

The aim of any characterisation method is to determine some quantity that describes both the active and passive behaviour of a source in such a way that it may be used to make forward predictions under operational conditions. Depending on the method used this quantity may or may not be an independent property of the source. In this section the blocked force is introduced as an independent source quantity and an in-situ measurement method outlined.

With the characterisation of structure-borne sources having been a topic of interest for many decades numerous works have been completed in the field. Consequently, numerous methods have been put forward, including free velocity, operational interface force[2], blocked force[3;4], the source descriptor[5], the characteristic power, mirror power and maximum available power[6] and pseudo forces[7]. Of these, the only standardized method (BS ISO 9611) is currently the free velocity. However, regardless of its standardization the free velocity approach is seldom used in practise. Its lack of uptake may be put down to the practicality of simulating the required 'freely suspended' mounting condition as well as the potential variation in mounting conditions between characterisation and installation. A more common approach is operational force method, notably within the automotive and aerospace sector[2;8]. The operational force method, also referred to as inverse force identification, forms the basis of classical TPA (transfer path analysis) and has the advantage that it allows for measurements to be made in-situ,