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VIBRATION AND NOISE RELATIONSHIPS - SOME SIMPLE RULES FOR THE MACHINERY DESIGNER

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INTRODUCTORY REMARKS

At present, three to five million workers are going deaf in the U.S.A. as a result of excessive noise at their places of work. There are laws calling for noise reductions, but the capital cost of such reductions has been estimated in some industries as being as high as 10,000 dollars per man at risk.

The reason for the high cost lies in our inability to reduce noise once a machine has been designed and manufactured, except by enclosing it in an expensive noise proof enclosure. Such a practice is often unrealistic and anti-productive, and the problem remains acute.

It is an axiom of noise control that the nearer to the source a noise control measure can be made, the cheaper it is, and the more certain the cure.

Unfortunately the noise energy can be very small, as low in some instances as 10^{-8} of the used machine energy, and even in the worst case need be no larger than 10^{-2}. The need to understand in fine detail the nature of the several sources in any machine is therefore obvious.

What is more the ear is only sensitive to the 'order of magnitude' of any reduction, and improvements which would merit a Nobel Prize in many areas of study go un-noticed by the human ear. For both these reasons, workers in source acoustics are rare, they find it difficult to obtain finance, and the law goes unheeded in many countries.

THE SCOPE OF THE PAPER

This paper attempts to bring together the basic relationships which can be shown to exist between noise radiation and the factors which cause it; the sharp impacts involved in the work or handling process, whether it be necessary or a result of lack of understanding of its acoustic consequences, the vibration left in the frame of the machine after the impact has occurred, the degree to which this vibration dissipates itself as radiated sound or is absorbed harmlessly as heat arising from internal damping. It shows that apart from increasing structural damping, considerable reductions of noise can be obtained by lowering the preferred frequencies of structural excitation to cause a mismatch between these and the frequencies at which sound is radiated from a structure most efficiently, allowance being made for the behavioural characteristics of the ear, and the particular form of the countries legislation.

This is all incorporated into two basic equations which are so constructed and simplified as to permit design engineers to check quickly the wisdom underlying their design judgements from the viewpoint of noise emission, as well as those other aspects of accuracy, operation, stress, fatigue, cost reliability,

appearance and so on, all of which they have learnt to cope with in the past.

One of the forms of the noise equation emphasises the need to keep to a minimum in all machinery components the rate of change of force for any application and the way this can be achieved by increasing the softness or resilience between members. Some examples which are obvious, but nevertheless indicate the universality of such a concept are the reductions of noise transmitted by footfalls if a carpet is fitted, or the reductions of noise from bottle impacts if glass is replaced by plastic.

These are obvious, but large noise reductions can also be obtained by easing the explosive processes in diesel engines, by preventing the sharp impacts spreading to other parts of drop hammers and punch presses, by reducing the sharpness of many impacting mechanisms in the packaging or textile processes, by softening the impacts associated with carrying large billets across floors and throwing forgings into heavy containers. In the lecture, two examples are given of how the noise energy can be reduced to a hundredth (which means a hundred machines will give the noise of one now) by the application of such principles.

The author is of the view that regular application of these principles over the years, and the associate ones relating to air noise can eliminate two thirds of the existing noise problems in factories at little if any cost, and with no loss of productivity.

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