

Technical Brief No. 50

All Technical Briefs are based on past projects at RH Lyon Division

Buildings
Civil Structures
Aerospace
Transportation

Statistical Energy Analysis

Sound and vibration as “heat”

Statistical Energy Analysis (SEA) was developed in the early '60's at BBN based on the work of R. Lyon at the University of Manchester in England. It is a way of predicting the distribution of sound and vibration in complicated structures. Originally applied to submarines and spacecraft, it has additional applications to the commercial shipping, construction, and transportation industries.

The range of applications of SEA is very broad. The largest number of applications remains in the aerospace and transportation industries, where it is used to predict the structural response to environmental disturbances and internal noise. Interior and exterior noise of rail traffic, automobiles, and airplanes are now standard calculations using SEA. However, a growing range of applications is to civil and commercial building structures.

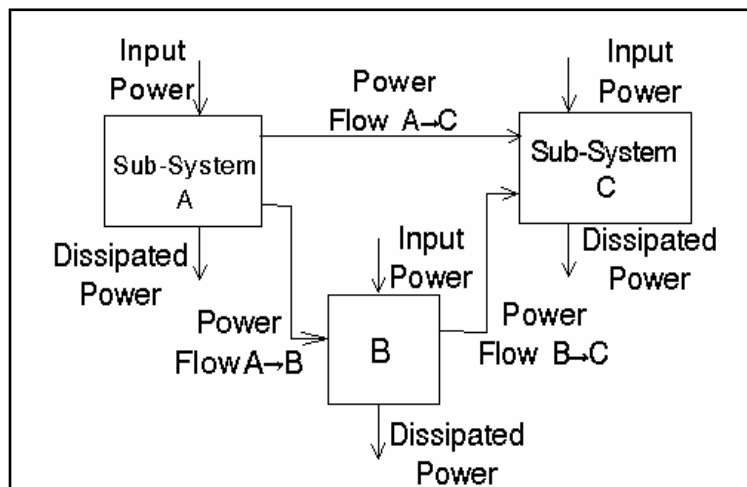
Noise and vibration are important in the planning and design of buildings for example, and SEA is about the only method that will allow one to make estimates of how the sound and vibration will be distributed through the building. It is then used to predict the benefit of noise mitigation procedures, which may include changes in the locations of equipment or structural features added to reduce the noise. For each potential modification, the NC ratings for the building spaces can be predicted due to both external noise and the vibrations of the equipment within the building.

The breakthrough made by SEA is its treatment of both sound and vibration in a unified manner by considering the energy of vibration and sound. The transmission of energy from one part of the structure to another is treated much like the flow of heat, flowing from regions of higher

“temperature” to lower. Disturbance sources put noise energy into the structure at their point of attachment, and energy is lost from the structure by damping or sound radiation and absorption.

It is possible and usually desirable to combine SEA calculations with measurements. The SEA parameters (damping, modal density, coupling loss factors) can be estimated independently, but measurements may be needed to confirm or establish their values. Fortunately, the measurements usually involve the customary methods used by consultants in sound and vibration using standard equipment.

Typical kinds of measurements include sound or vibration decay rates to determine acoustical or structural damping, vibration and/or sound transfer functions (the amount of sound or vibration at one place due to excitation at another) and the amount of vibratory or acoustical power fed into the system by the disturbances.



A major development in SEA technology has been computerization of the calculations. Some of the first large scale computer programs for SEA analysis were developed by Japanese shipbuilding companies. A large number of companies and some government laboratories have written special purpose SEA programs for their internal use. The first commercial SEA program was SEAM[®], developed by Cambridge Collaborative, Inc. of Cambridge, Mass. Other programs are also available, including those from Vibro-Acoustic Sciences Inc. of San Diego, Calif. (AutoSea[®]), and LMS Corporation of Leuven, Belgium (SEADS[®]).