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Vibration Test Lab

# Vibration Testing and Control

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**Abstract:** Research surrounding vibratory analysis is complex in nature. The way structures respond to external forcing functions to the resulting effects that they carry out to neighboring structures can only be predicted from generic data and succeeding calculations. Advances in vibration control and signal analysis have allowed for stability in both **manufactured products** and **utilized equipment**. The scope of work involved to this extent, requires an understanding of how **control system implementation** can be used to foresee the natural behavior of materials through testing. Over testing, under testing, resonance control, as well as many other test aspects can be directly attributed to the behavior of materials on the market, assuming that these materials have undergone qualitative testing beforehand. The intention of this presentation is to be mainly informative as to what vibratory analysis involves and the testing done to accommodate test specifications.

**Introduction:** We all have a general understanding of vibration. It "generally" involves some object or structure shaking, back and forth, up and down, or side to side at some designated frequency and amplitude. A few examples of vibration might include driving an automobile on a rocky road, experiencing something drastic such as an earthquake, or maybe even the aftereffects of turbulent air flow over an airplane wing. The key thing here is that **everything** vibrates. These things all undergo some level of excitation which induces resonation. But the main question here is why?-Why do these things vibrate or how do we stop them from vibrating? These questions highlight the importance of **vibration control** to obtain a desired vibration environment. The engineering design and establishment of those complex structures **wouldn't work or operate efficiently** without vibration testing. The property of resonation itself is apparent from the vibration of material at its **natural frequency** which is dependent upon the material's stiffness and mass. Since most structures consist of several masses lumped together, multiple levels of resonance can occur for the composite structure because each element has its own natural frequency; External or internal excitation can excite different **modes of that structure** because it would have multiple degrees of freedom to vibrate. One would only be able to slightly predict the response of a complex structure from extensive analytical and graphical calculations. However, with the application of vibration control, testing procedures are optimized to **effectively account for this unpredictability.**

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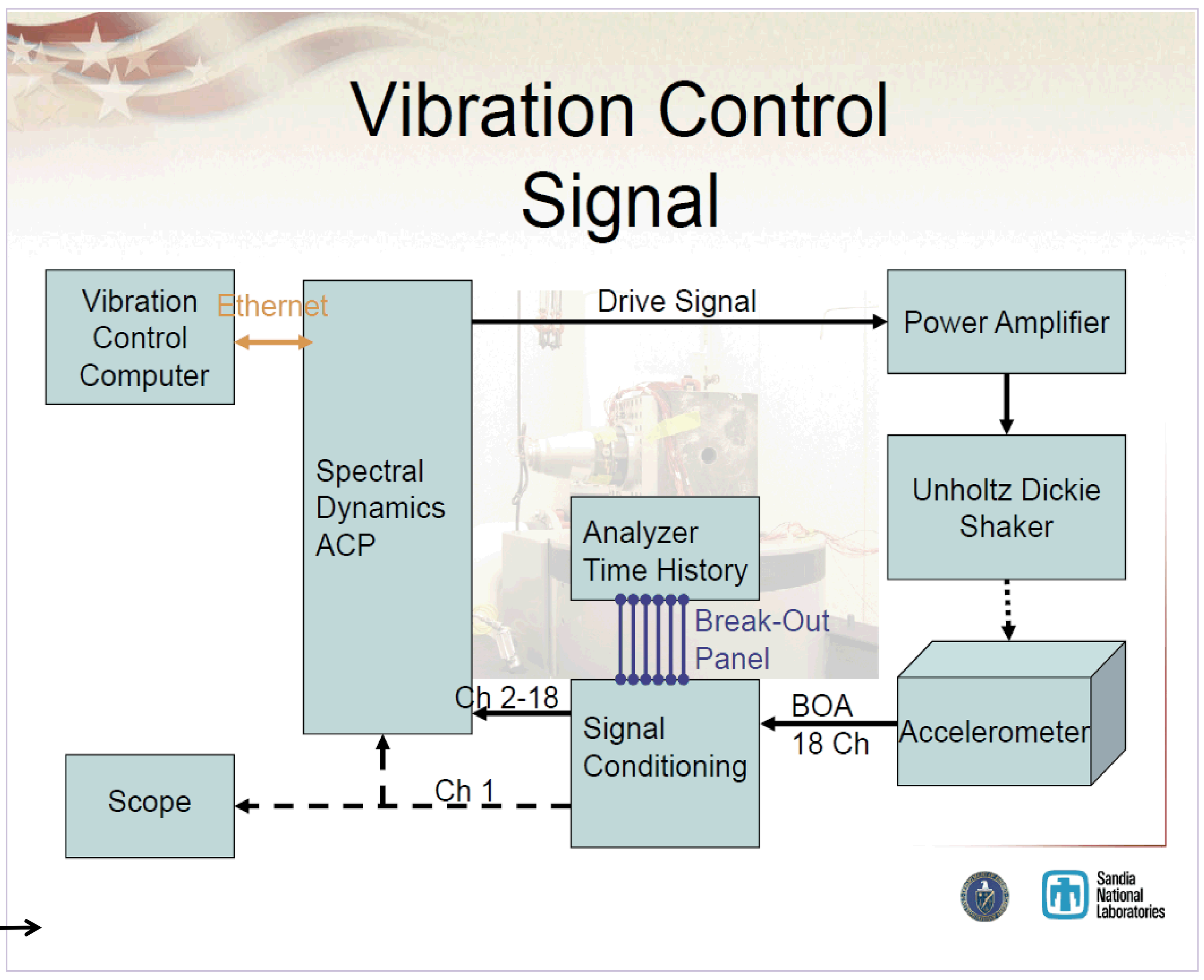
**Methods:** For vibration control, **test specifications** are the cornerstone to ensuring product reliability. My role as an intern was to **assist the test engineers in setting up** the test items and constraints and **monitoring the control inputs** to make sure that test simulations ran smoothly.

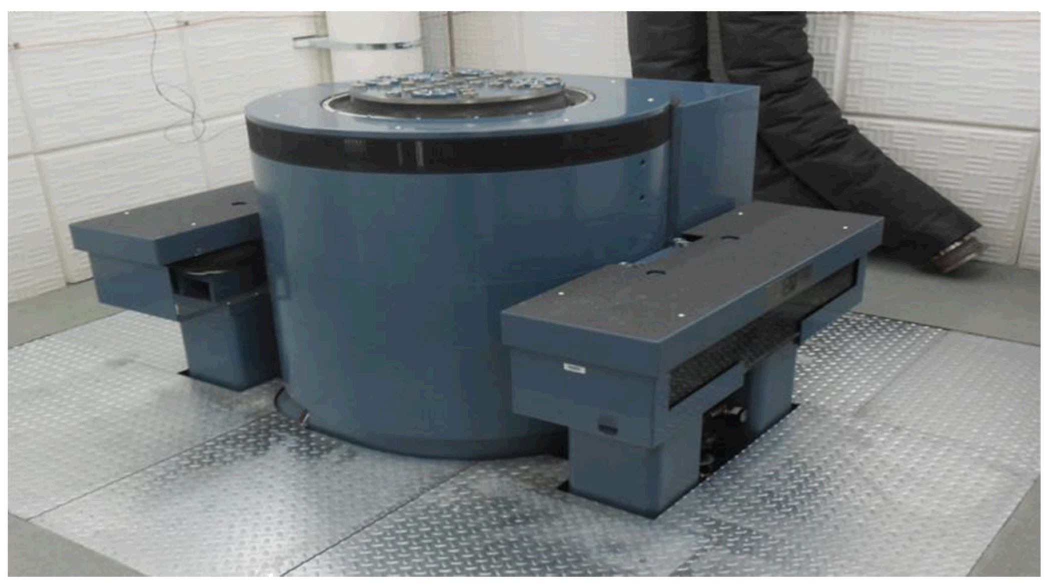
Depending on what test article needed to be tested, the setup configuration would be re-altered and control inputs rearranged to **replicate vibration environments** specific to the tests.

Control compensation, test machine capability, and DUT (device under test) durability were **three main factors** that heavily influenced the test progression.

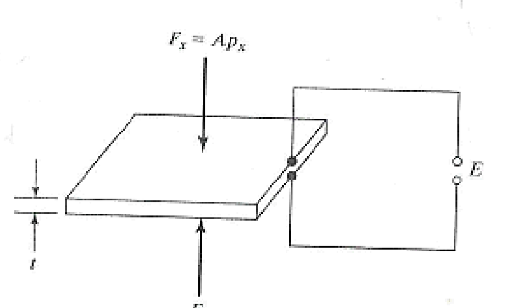
Active monitoring required analyzing an arrangement of amplitudes and frequencies in order to **understand the relationship between main-axis vibratory control and off-axis control**.

Time was also spent **operating real-time analytical equipment** such as an oscilloscope. The instrument served as a secondary analyzer for signal acquisition.

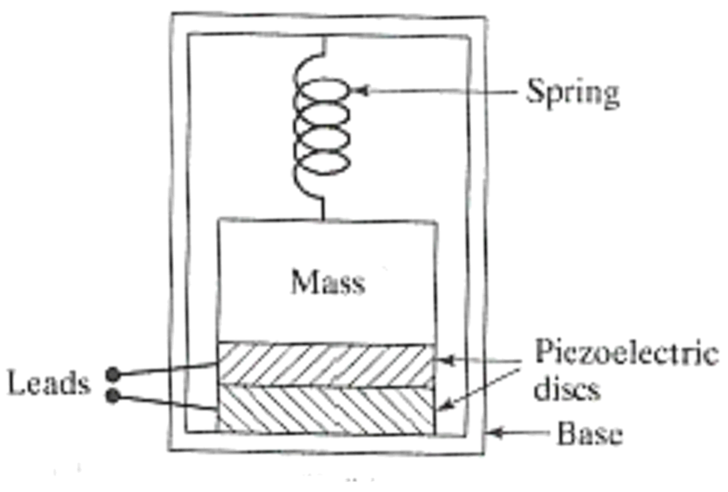


Here is a pictorial representation of a machine used for vibration testing. This device is called a "shaker". It is used to **implement excitation** into a structure at a specified control point.



The force induces a voltage (E) from the piezoelectric disc.




*Singiresu S. Rao. "Mechanical Vibrations". 5th ed. (2011): Pg. 876. Print. Copyright © 2011. 2004 Pearson Education, Inc., publishing as Prentice Hall, 1 Lake St., Upper Saddle River, NJ 07458.

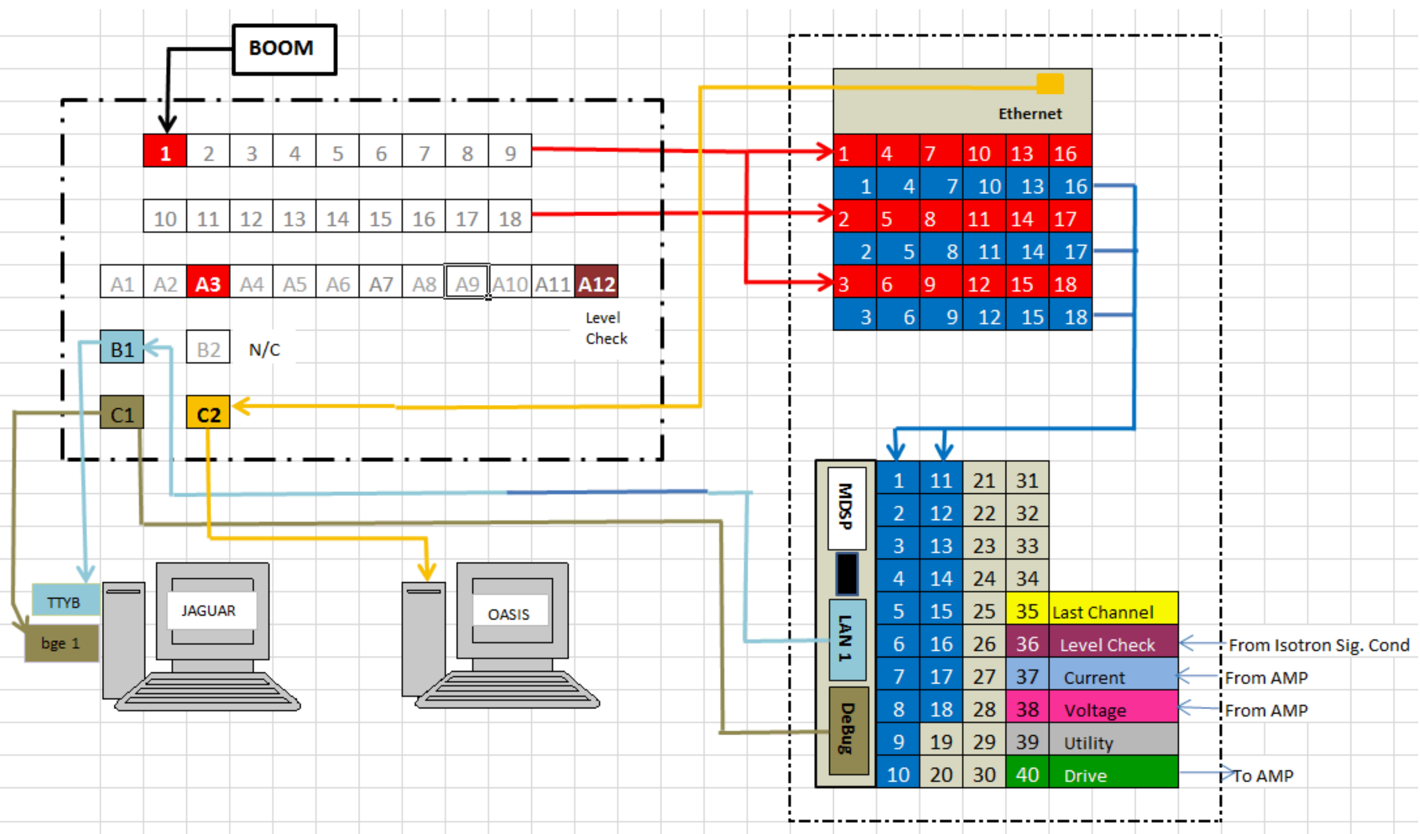
Here is an example of a piezoelectric accelerometer. This transducer converts **acceleratory motion into electrical signals**. It is most widely used because of its durability and sensitivity.

To successfully test customers' **components**

Tests must be **properly set up**

Engineers must perform a **thorough analysis**

Test items must **undergo specified conditions for the test**




This diagram shows the **cable connection** between the **control CPU**, the **boom** (external liaison between the transducer and the signal conditioner), and the actual **signal conditioner** itself (OASIS).

**Results:** Most of the results from performing the vibration tests involved identifying input parameters that served as causes for **failure of the DUTs**. If the structural response of the DUTs were favorable then they were ready for the next phase of testing.

**Discussion:** Many factors influence whether a test article is subjected to the correct environment from a shaker. Efforts are in place to utilize multiple -degree of freedom shakers to more accurately represent vibration environments. This will help to prevent over-testing or under-testing from occurring.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