Proposed Hands on Demostrations:

1 Day One, Lecture Session

1.1 Review "Shock and Vibration Measurement Technology"

1.1.1 Chapter 4, 5 & 6 (Error sources, performance characteristics, accelerometer types & electronics)

2 Day One, Calibration System Demonstrations

Endevco Personnel will demonstrate calibration systems as an introduction to the workshop session.

2.1 High Frequency Air Bearing Shaker

2.2 Low Frequency Air Bearing shaker

2.3 Hopkinson Bar Shock Calibration (SMAC)

3 Day Two, Hands-on (Workshop) Session

3.1 Small groups of students (3-5), each working on an exercise

Maximum student participation should be encouraged, but with explanations and supervision by an Endevco employee.

3.1.1 Approximately 2 hours per exercise

Each exercise should be explained by either the instructor or a knowledgeable Endevco employee. Then the students perform the exercises and make notes on the results for later discussion in the concluding/summarizing session.

3.1.2 Each exercise emphasizes an error source or performance characteristic

Specific exercises can be selected depending on availability of Endevco resources and test accelerometers, size of class and time available. The instructor will circulate among whatever simultaneous exercises are in progress. Each exercise MUST be supervised by an Endevco employee, who should also be knowledgeable about the exercise and the equipment operation.

3.2 Exercises

Each exercise will need to be supervised by an Endevco employee and the instructor. Ideally, the equipment will be set up and the exercises rehearsed the day before the class starts. Depending on class size, and personnel availability, more than one exercise may be held simultaneously.

3.2.1 Mounting techniques

3.2.1.1 Adhesives

Compare frequency responses of various adhesive-mounted accelerometers with a stud-mounted reference.

Required Endevco resources:
Shaker system (small shaker or air bearing calibration shaker will suffice). Two channels of signal conditioning and two or more accelerometers. At least one of them should be stud mount. Adapter to attach the stud mount accelerometer to the shaker (if necessary). Various adhesives, waxes, double-back tape, etc. for mounting the test accelerometers. Different sizes (weights) of accelerometers will be desirable/helpful). Torque wrench and appropriate adapters. Two channel oscilloscope or other readout instrument.

Procedure:
The student team will properly torque the stud mount accelerometer to the shaker to use as a reference. Then they will use the different adhesives, tapes, waxes, etc. to attach the test accelerometers to the shaker, one at a time. The shaker will then be swept through the available frequency range, and the test output compared to the reference output.

3.2.1.2 Adapter blocks

Compare frequency responses of accelerometers on various adapters and blocks with stud-mounted reference

This exercise is similar to 2.2.1, but compares test accelerometers mounted on adapter blocks and isolated mounting studs to a reference that is directly stud mounted on the shaker. Resource requirements are the same, except the adhesives are replaced by various adapters and isolated studs.

3.2.2 Cable routing/noise

Measure noise outputs of various cable configurations and restraints; low noise and non-noise-treated cables

Endevco Resources required:
Shaker system, low-noise cable six to ten feet long and non-noise-treated cable of similar length. Charge amplifier and readout instrument; also, an Isotron signal conditioner and some samples of cables used with Isotron accelerometers. *No accelerometers are necessary.*

Procedure:
The cables are attached to the signal conditioners and the other end is attached to the shaker. The shaker is run at various frequencies with the different cables allowed to vibrate freely and/or bang against a hard surface. The students will note the differences in noise generated by the different cables, held with different tensions and before and after abuse such as stepping on them, bending them too sharply, etc.

3.2.3 Case strain

Mount different accelerometers on base bending beam and compare outputs

Endevco Resources required:
Base bending test beam, 4 or 5 accelerometers with different base bending sensitivities, signal conditioning for accelerometers and for strain gages on the beam, one Endevco employee.

Procedure:
The students will perform base bending test on different designs of accelerometers, using the base bending test beam and signal conditioning/readout.

3.2.4 Thermal transient response

Monitor outputs of various accelerometers when subjected to hot or cold transients. If the signal conditioning has adjustable low frequency response, that can be used to illustrate its effect on the low frequency thermal transient response.

Endevco Resources required:
One Endevco employee; shaker system; 4 or 5 accelerometers with different thermal transient sensitivities; signal conditioning; two-channel oscilloscope or equivalent; heat gun and cold source.

Procedure:
Students will mount accelerometers on the shaker and monitor outputs at stable room temperature and the responses when subjected to heat and cold transients.

3.2.5 Transverse sensitivity

Measure transverse sensitivity of various accelerometers

Endevco Resources required:
One Endevco employee; transverse sensitivity test setup; several accelerometers (at least two of which should be the same model number).

Procedure:
Endevco employee will mount accelerometers on the test setup and run transverse sensitivity tests to demonstrate that sensitivity is directional and that different accelerometers have different sensitivities.

3.2.6 Mass loading

Measure responses of different weight accelerometers on a beam; compare to common reference

Endevco Resources required:
One Endevco employee, shaker system with cantilever beam or other simple structure attached (the test structure should have a natural frequency below 100 Hz), several accelerometers of different masses (weights), signal conditioning, one reference accelerometer, two-channel oscilloscope or equivalent.

Procedure:
Students will mount the reference accelerometer on the shaker or at the root of the beam. Test

accelerometers of various weights will be mounted to the beam and the system swept through a range of frequencies. The outputs of the reference and the test accelerometers will be compared to show the effect of mass loading of the different test accelerometers.

4 Discussion of Results and Conclusion

Instructor and Endevco participants will lead discussion of results with students. Students will be asked to evaluate the total Advanced Class and provide feedback for future improvements.

NOTES:

1. Class should be scheduled from 8:00 AM to 4:00 PM both days.
2. I am estimating two hours at the end of Day One for the calibration system demonstrations.
3. We will need at least three exercises, which should take about six hours on day two. Then, we can have one hour for the conclusion/summary discussions.
4. The exercises can be done in any order.
5. The exercises will be a good opportunity for Endevco to show off any new instrumentation that you want to promote.
6. You might want to photograph and or video record the exercises for future training purposes.