A Shift in the Noise & Vibration Market: The Demand for Cost-Effective Standardized Testing

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May 2004

CURRENT SITUATION

Over the past five years, MTS Systems Corp. has witnessed, through customer feedback from around the world, a slow but definite shift within the noise and vibration practices of the automotive industry. The automotive industry represents more than half of the $300 million market for noise and vibration data acquisition and analysis hardware and software.

Two trends have emerged:

a) **Target Cascading:** Automotive OEMs and their suppliers have been actively working, together or separately, to define in-vehicle targets and cascade these targets to sub-system or component level targets. For example, interior acoustic targets can be cascaded down to vibration targets of powertrain components. This activity is, in general, conducted with high-end exploratory noise and vibration tools, with a wide range of capabilities and high channel count. These tests focus first on the localization and quantification of the sources (with techniques such as sound power, sound intensity, and acoustic holography) and next on the identification of the paths (both airborne and structure-borne) with techniques such as noise path analysis and panel contribution analysis.

b) **Standardized Testing:** More and more companies (most notably automotive suppliers) have been asking for customized software and/or test benches to efficiently and consistently test the performance of their products (components or sub-systems). This request is a direct consequence of the target cascading trend. Once the target for the sub-system is established, the supplier is responsible for implementing the target in their product development process and then using it to validate design changes. In another similar scenario, the central noise and vibration lab develops test procedures and algorithms to validate a product, and these methods need to be spread to company labs or manufacturing sites around the world.

The above classification suggests that the noise and vibration testing market has split into two main segments. The first established market segment is that of *high-end, exploratory testing* characterized by a need for generalized, interactive tools able to easily perform different tests and analyze data for troubleshooting, exploration and design insights. The second growing segment is that of *standardized testing* used for repetitive evaluation against targets, benchmarking to set targets and variability analysis of products in final configurations.

The automotive noise and vibration testing community, therefore, currently has two priorities:

1. To support target cascading through more efficient sources and paths identification.
2. To define, create and deploy standardized tests internally and at remote locations around the world to easily validate products against targets.

VALIDATION

This market trend was verified in a survey conducted by an independent marketing research company in 2003. The survey included representatives of automotive OEM, Tier 1 and Tier 2 suppliers in North America, Europe and Asia. The people interviewed were noise and vibration lab managers responsible for providing computer-aided engineering (CAE) and testing services to different divisions inside their company. All persons interviewed worked for laboratories supporting product development and validation, only one worked at a research laboratory.

The primary objective of the survey was to test the hypothesis that there is a growing need for standardizing test procedures. Furthermore, we wanted to better understand how companies define standardized versus exploratory tests, why companies want to standardize and what barriers exist to expanding standardized testing.

Survey Results: Standardized vs. Exploratory

We found general agreement on the definition of “standardized test.” This is a test:

- With a fixed number of channels, transducers and test conditions
- Based on government, professional organization and/or company procedure
- Which should be easy to setup and execute by an individual with technician-level skills
- With automatic generation of a test report in company-approved format
- With automatic archiving of test results in a company database

In contrast, an “exploratory” or diagnostic-type test is one where the above parameters are not defined or known a-priori and have to be identified by the noise and vibration specialist, based on the problem under investigation.

Within every company interviewed, we learned the demand is high with several respondents indicating that they need to perform from two to ten times more noise and

vibration testing to keep up with their testing requests. Respondents verified that target cascading and target compliance drove the growing demand for testing as tier suppliers have targets for their products, and tests are needed throughout product development and in manufacturing to verify compliance with targets.

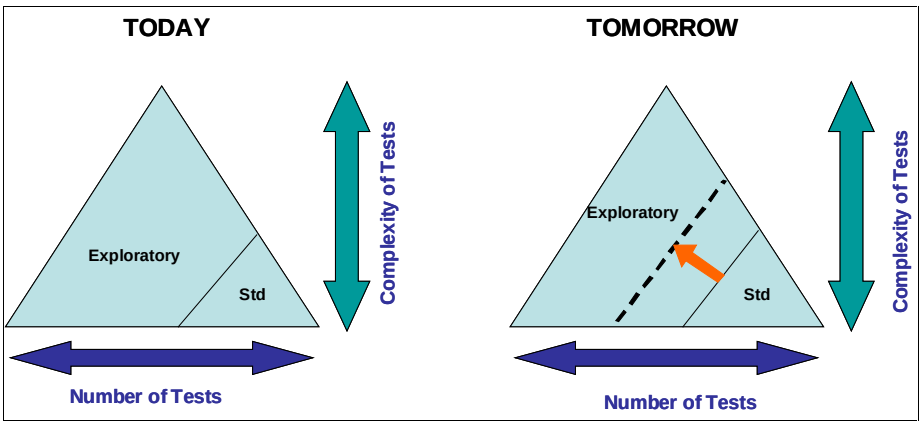

Figure 1. Trend of exploratory and standardized test distribution

Repetitive testing dominates this demand presenting a significant trend towards more standardized tests that can be performed by technicians and deployed globally.

Today, in most labs in North America, 70% of testing is the standardized type and 30% remains exploratory. The opposite appears to be true today in Europe, possibly because of the different role of central labs. In Europe, the central lab is, in general, a true research lab, with most repetitive testing occurring at local labs in remote locations. In North America, the majority of the central labs support product development, performing repetitive testing as a service to the divisions within the company to gain design insight and verify target compliance.

However, regardless of geography, the respondents consistently indicated that the increased demand for noise and vibration testing was largely for standardized testing.

Survey Results: An Illustrative Example

The following example arose during the survey:

At a supplier in North America, a noise and vibration specialist working at the research and development lab is tasked to improve the sound quality of an existing component as a result of more stringent acceptability requirements from the OEM. The specialist uses MTS Systems' exploratory noise and vibration software to identify acceptable noise performance in the vehicle and develops a new component specification. The specialist defines a test procedure for the specification and verifies the requirements on a small sample of components.

With the specification verified and the test procedure established, the test is implemented by a summer intern using National Instruments LabVIEW software as a standardized test

in an assembly line functional tester. The new component specification test is deployed on assembly lines to identify unacceptable components (those with noise above the specific target level). The choice of LabVIEW is well received at the manufacturing facility in India because of its low cost deployment, the simplicity of the user interface and local availability of LabVIEW programmers for maintenance of the test.

Survey Results: Noise & Vibration Community Needs

Despite the substantial increase in testing and the trend towards standardization, the survey revealed that commercial noise and vibration acquisition and analysis products fell short of providing a solution for standardized testing that would address the growing demand.

The survey identified four key requirements for a standardized testing framework:

- Ease of use
- Ease of implementation
- Data consistency
- Cost effectiveness

Ease of Use:

A recurring theme from the survey is the desire to reduce the dependency on experienced engineers for testing by assigning technicians to perform repetitive tests. A second theme is the need to deploy these tests to operations around the world.

Respondents consider the complexity of current commercial software as a fundamental hurdle to delegating testing to technicians or to deploying the tests globally. “Idiot-proof” is one description given.

This is not surprising. Vendors design their software to meet the sophisticated exploratory needs of noise and vibration experts. Hence, the powerful software packages can require weeks of training and months of use to master, even for specialists.

Yet, the variety of tests, unique to different components, systems and noise sources, means buying a simple special-purpose product is not an option.

Conclusion: The standardized testing framework must be easy enough for a non-specialist, such as a technician, to use. Companies need to be able to create and customize their own tests.

Ease of Implementation:

The survey surfaced three approaches to standardized testing today:

- Train more engineers to use the exploratory software to perform a documented test.

- Purchase a special-purpose product dedicated to the task.
- Program the exploratory software to automate and customize a standard test.

Respondents generally consider the last option to be the prototypical notion of a "standardized test." For years, central noise and vibration labs have been using automated routines or scripts developed within high-end, exploratory noise and vibration software.

The survey indicated that programming these standardized tests is difficult and time-consuming. Some respondents spent hundreds of man-hours programming and perfecting a single standard test.

Furthermore, only a few specialists are qualified to program these standard tests. Not only does the specialist require a deep understanding of noise and vibration, but they also must have experience with programming and with the particulars of the proprietary programming language of the high-end noise and vibration software.

These proprietary programming languages have a small user community and, therefore, lack the critical mass to create a growing base of reusable, shared and supported code. Also, often new releases of the underlying software do not completely support user-written programs resulting in a time-consuming debugging effort by the noise and vibration specialist (if he or she can still be found).

Finally, the same specialists that would now need to spend hundreds of hours programming, debugging and maintaining these standard tests are the ones in highest demand for their fundamental noise and vibration expertise.

Conclusion: The standardized testing framework must be easy to implement for a noise and vibration specialist to define a standard test without expertise in programming. The underlying programming language should have a wide user community and should support tests written on previous versions without additional effort.

Data Consistency:

When asked "why standardize?" the universal response is "consistency, quality and efficiency."

At some of the companies interviewed, noise and vibration testing is a component of Six Sigma quality efforts. Generally, the interpretation of test results is the province of the noise and vibration specialist, though basic analysis and quality of results is increasingly expected as part of the test itself. As specialists apply statistical approaches to data, consistency of the results is required so the

variations in tests do not cloud variations in the as-manufactured or as-designed component or subsystem.

At other companies, the global deployment of testing across the enterprise and into the supply chain drives the need for consistency. The transportability of test data is a fundamental need of modern noise and vibration labs. Absolute acoustic label data, such as sound power and transmission loss, represent good acoustic performance targets because they are tested according to standard procedures aimed at equalizing effects of environment, load and boundary conditions. In this sense, these quantities are transportable (i.e. they are the same regardless of the lab in which they were tested).

Three issues underlie the data consistency problem:

- The complexity of the software tool and the lack of automation mean that different people running a test often do not get consistent results.
- The use of different hardware/software solutions for exploratory and for standardized tests because of cost or ease-of-use impedes consistency.
- Commercial offerings do not facilitate sharing of tests across the enterprise or proper archive and annotation of data sets.

Conclusion: Producing consistent test results should be a natural outcome of a standardized test framework. The software should prevent inconsistent usage. Similar software and hardware should be available for exploratory as well as standardized use. Archive and proper annotation of test results should be automatic.

Cost Effectiveness:

By far the most common complaint is the cost for current commercial noise and vibration offerings. Respondents recognized different elements of cost including:

- Initial cost
- Standardized test implementation cost
- Training cost
- Quality cost

Initial Cost: Established noise and vibration labs have traditionally attempted to utilize high-end, exploratory tools for all types of testing. Currently, according to survey respondents, exploratory tools are being misapplied in the standardized testing realm. These tools are considered “overkill” (i.e. too expensive and too difficult to use) by most respondents, particularly at remote test facilities where noise and vibration budgets and skills are limited.

Standardized Test Implementation Cost: As described earlier, implementing a standard test can require hundreds of man-hours to define and program and additional investment to maintain. Furthermore, only highly-paid specialists are qualified to define these tests making the process of standardization expensive.

Training Cost: As described earlier, the complexity of exploratory tools is high requiring a significant investment in training and a high skill level often even for basic tests.

Quality Cost: When test results are inconsistent, the tests are not meaningful. These "wasted tests" are a productivity cost associated with the lack of standardization. A more significant, hidden cost arises when incorrect decisions are based on inaccurate data from inconsistent tests.

Conclusion: In order to deploy standardized tests widely, the initial cost for software and hardware should reflect the type of test being performed and be commensurate with the available budgets. By deploying a standardized test framework, companies could lower the cost of implementation, training, and quality.

CONCLUSION

Our survey confirmed a substantial shift in the automotive noise and vibration market from exploratory testing to standardized testing in support of target cascading and deployment of common test procedures to a wider community.

This shift is consistent with a rapid growth in the demand for noise and vibration testing also evidenced in the survey – a demand for two to ten times more testing than currently supported. Only through the standardization and spread of noise and vibration testing into the enterprise and through the supply chain will this demand be met.

However, current commercial noise and vibration offerings do not support this shift and, instead, act as a significant barrier to companies meeting their noise and vibration demands. The survey uncovered an unmet need for an economical framework for standardized testing with four major characteristics:

- Ease of use
- Ease of implementation
- Data consistency
- Cost effectiveness

MTS and National Instruments recently announced an agreement to deliver just such an economical framework for standardized noise and vibration testing to help companies:

- Meet the growing demand for noise and vibration excellence
- Leverage their limited noise and vibration expertise
- Standardize processes and data worldwide across divisions and suppliers
- Reduce the time and cost for noise and vibration testing