Automotive NVH Career Needs

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An award for career achievement makes for a look back at the lessons that may have been learned over the years. The real meaning of engineering was impressed on me by my father, who worked for Sir Harry Ricardo since the early days of that consulting, research and development company. The fundamentals of how things can be designed and developed to do useful things in an efficient way became clear. Those early impressions stay critical today, despite technological changes. As an independent consultant for the past 20 years, many of these lessons have been vital.

My involvement with noise and vibration (N&V) began by accident; my final-year mechanical engineering project at Southampton University in England involved making a one-third-scale model of a space-frame car chassis. The university workshop space in use was made "unavailable" and I took up the invitation to look at the possibility of early detection of gear failure by the radiated noise. (The answer was "yes" – but usually too late to be of use.)

I worked with various people in the Institute of Sound and Vibration Research (ISVR) at Southampton. Fired by the interesting evolving technology of N&V at that time, I went on to take a masters degree at ISVR, with my professor being Theo Priede, who forged much of the fundamental knowledge in the engine and vehicle noise field.

Lessons learned from those projects remain critical. Calibration before, during, and after making measurements is seen by some as old-fashioned, but even "all-digital" systems have some analog components that can drift. Analog narrow-band frequency analysis from recorded tape loops taught dual lessons, in both patience and the benefits of project planning. When each tape loop analysis could take a couple of hours, due to the scanning rate limitations of the narrow-band filter, having a good idea of the purpose of each measurement is preferable to launching a wide mapping and hoping that "something will appear" even when the analysis is relatively fast.

A deeper appreciation of preparation was sometimes learned the hard way. I skipped some lectures featuring the use of Bessel functions, thinking that engine design would not need them. A few years later I needed that knowledge to provide a client with a calculation covering engine cylinder cavity resonance frequencies for knock detection purposes. The self-teaching process is harder than learning through lectures! The need for information is sometimes unpredictable, and it's better to be prepared since that provides more options.

Engaging one's brain and thinking about the potential results of an experiment and their application can be as effective as extra work and it can pay dividends. Avoiding time charges from rental equipment and facilities can make the difference between success and failure, either personally or corporately.

Attention to detail is sometimes annoying, but experience of a friend demonstrated how critical "extraneous" factors can be. Carrying out some vehicle N&V development tests, using the classic A-B-A procedure to evaluate each component change, one stage produced a puzzling result. Considerable time was spent investigating potential reasons, but it was found that an enthusiastic technician had coincidentally used an upholstery cleaning spray containing a simulated leather smell. The resulting "luxury" impression had caused a distraction and a significant shift in the subjective assessment – only made evident because it went the "wrong" way!

The year 2013 sees the 50th anniversary of the publication in the UK of the Wilson Report on environmental noise levels in London. This government report had a major effect on politicians, who passed the world's first effective road vehicle noise legislation which came into effect a mere six years later. This led to a large amount of work for N&V engineers, spreading relatively quickly across Europe and within a few years even to the U.S. (Some may remember the EPA Office of Noise Abatement, 1972-1978.)

The requirements on manufacturers spurred considerable R&D work, and because of this I went to work reducing engine noise for Cummins in their European Technical Center. After a couple years I went back to Ricardo in Shoreham to set up their first department devoted to engine and vehicle noise measurement and reduction. There was a revolution to come, the dawn of digital technology in noise and vibration measurement and analysis. The adoption of FFT analysis caused more change than anyone could have imagined – and the echoes continue nearly 40 years later, with a workshop devoted to it at an SAE Conference earlier this year.

Another long-lasting change was the vehicle noise test procedure that is almost, but not quite, standardized around the world. The original UK test was adopted internally and has evolved. Changes have continued to be made over 45 years. In the early days of its use some of these were substantial; for example, making gearing less critical to the result. More recently, the changes have become smaller – but the legislated levels continue to fall. Meeting the current levels is now a relatively well-known and well-developed technology set, although the inclusion of tire noise limits has added another development hurdle.

The international development of quieter and more refined vehicles required the evolution of considerable engineering know-how, and this took many years. A by-product for me was the amount of time I spent visiting the U.S. and other countries, working with a variety of clients. The lessons I learned in the process were more complex aspects in communications, both of the technical and also the personal type. Understanding different working practices in different companies can be critical to mutual understanding and engineering progress. Differences are often much more than just language and measurement standards. I learned to try to deal with technical matters using standardized methodology so that the similarities and differences in individual cases were clear. Otherwise, confusion spreads into chaos. This is seldom a good recipe for effective consulting support.

In the course of my engineering career, the adoption of improved design techniques has had a dramatic effect. Many prototypes used to be designed, procured and tested before being abandoned. The reasons were various, but it is interesting to note that the "failure" rate has fallen from perhaps 80% to less than 20%, with a corresponding increase in the level of disappointment rather than resignation. This progress has been won by investing in greatly improved design techniques and capabilities. Most of these are powered by increasingly affordable computing facilities. An example that illustrates this in the N&V area is modal analysis, where engine models were large and needed computers of the largest size. These were typically only available to the finance departments, resulting in some interesting arguments about usage and costs. Today, computing availability worries have been replaced by the cost of training users.

Perhaps one of the most critical skills learned over the years has been to attempt understanding and empathy with others, especially clients. A lack of understanding of N&V basics can make this very challenging. A continuing example of this is coping with those who fail to appreciate the logarithmic scale. Politicians sometime fall into this trap

Based on a keynote presentation at the SAE 2013 Noise and Vibration Conference and Exhibition, Grand Rapids, MI, May 2013.

– Mayor John Lindsay of New York (*circa 1973*) is alleged to have promised: "If 80 dBA is a low enough limit for others, then I will adopt half of that – 40 dBA."

Dealing with some organizations can be challenging, as illustrated by the founder of EDS who went to work with GM. Ross Perot was not impressed by the reliance on committees. "In Texas, if we see a snake, we just kill it – we don't appoint a committee on snakes."

Throughout my career, it has been my pleasure and honor to have known and worked with a wide range of outstanding designers; a varied group of people but all of the most effective have been a rare mixture of creative talent and a fine set of engineering judgements, blessed with wonderful imaginations. Engineering needs to recognize such talents.

The field of N&V has been a dynamic and exciting one for many of us. More developments are still emerging and I hope to continue active involvement. The present most exciting developments in the vehicle area are perhaps the useful nature of complete vehicle modeling systems such as GT Power, which enable many optimizations and compromises to be made at the most effective and cheapest stage – early design decisions. Similarly, after a delay of some 30 years, we are now seeing the introduction of active exhaust systems (recently launched by Eberspecher.) The market and legislation will always determine what technology is brought into production. S/V

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