EDITORIAL

Death by a Thousand Cuts

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"Lingchi" or leng t'che in Chinese, "slow slicing." Also known as the "slow process" or the "lingering death." Lingchi was a form of execution used in China from roughly AD 900 until its abolition in 1905.

If you are reading this, there is a very high probability that you are painfully aware (pun intended) of the concept of "death by a thousand cuts" and how it directly applies to noise and vibration solution development. I seriously doubt that any of you need a detailed explanation of this concept, so I'll avoid preaching to the choir. However, I'll still summarize the conundrum here just to make sure we are all on the same page:

In N&V solution development, the optimum system performance is nearly always determined by the incremental summation of many small effects (countermeasures, design features, etc.) whose individual contributions to the whole system are nearly insignificant on their own, but whose contributions are a critical link in a long chain to success.

I am guessing that many of you have faced the challenge of justifying one or more of some N&V countermeasure that you have proposed in the face of cost, manufacturability, weight, etc. You may have even lost some of these challenges due to the fact that you could not produce objective evidence significant enough to tip the scale in your favor for that one particular countermeasure.

Perhaps I can help. I would like to share with you a couple of different communication techniques I have found to be fairly successful in changing the minds of those who challenge our design features and countermeasures. My hope is that you find these techniques useful and that they help you win some of these challenges. My strategy when confronted with these types of situations is to call upon the common sense of the "challenger" by pointing out analogous situations where they *know* it would be nonsensical to start eliminating features from the system simply based on individual contributions.

The first analogy I use is that of the spot welds in an automotive body structure. Alternatively, you could use the rivets that hold together bridges, buildings and airplanes. The concept is the same. When challenged in this way, here is what I would say:

Consider the many thousands of spot welds that hold together an automotive body structure. I challenge anyone to produce any evidence whatsoever, be it empirical or analytical, that clearly shows a net change in system *behavior of the whole body by the removal of, say, spot weld #3497. You can't. No one can. The effect of that one spot weld is way too small. If that's true, then we should eliminate it right? OK. What about the one right next to it? Show me evidence that removing that one has any incremental effect over the one before. No? Good, let's get rid of that one too. And the next one? Right. How about the one after that?*

I think you see my point. Keep on going and you'll end up with a pile of sheet metal on the floor. Yes, of course, somewhere along the way, there will be a measurable and significant effect, but where is it? Where do you draw the line? How much is one spot weld worth to you?

These are tough questions, and invariably the way to answer them is to emphasize the need to develop a holistic strategy designed around the effect of all of these spot welds, and then stick to it. Please, please, do not fall into the "line item veto" trap. It is a slippery slope, and a thousand cuts later, the patient will be dead. It is the same with N&V contributions.

I usually have a picture handy of an automotive body (such as shown in Figure 1) that clearly shows lots of spot welds during this discussion to really help cement the idea. Believe it or not, this line of reasoning has stopped many hard-charging challengers in their tracks. It just makes sense. Although it is somewhat infuriating for them to admit it and their first reaction is usually to try and rationalize their way out of it. Stick to your guns and you will most likely prevail.

The other analogy is actually kind of the inverse of death by a thousand cuts and involves the democratic process of voting, especially in large elections. I don't think there is a coined name for this, so I will simply call it "victory, one vote at time." In this analogy, I appeal to the pessimism that lies in most of us regarding the power of our single vote. I would say this:

Consider a general election. If you are realistic about the voting process, you will probably admit that one vote never (or rarely) wins an election and that your vote in particular, probably doesn't matter. If that is true, why bother voting? It takes time, costs money and besides, most of us are pretty unhappy about the candidates anyway. So why do it? Because it's the right thing to do, and if everyone acted on that same sentiment, no one would vote and the whole process would be broken. It is the incremental summation of many "small" votes that carries the election and enables our whole process of self government. It is the same with N&V contributions.

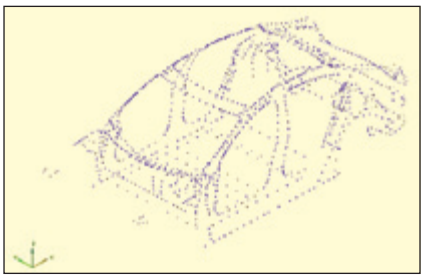

Figure 1. Typical spot welds on an automotive body.

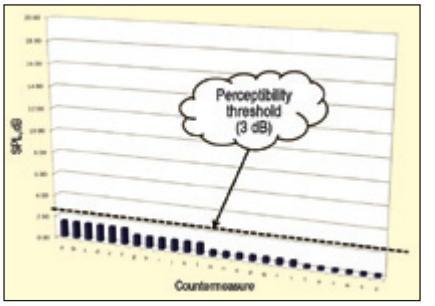

Figure 2. Delta SPL of each countermeasure.

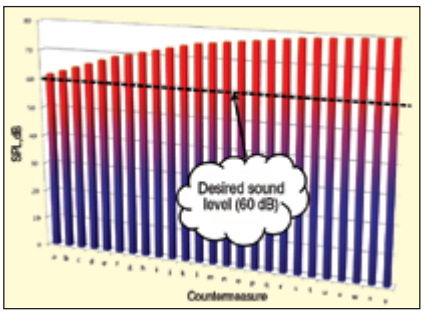

Figure 3. Cumulative effect of individual countermeasures.

I must admit that I prefer the spot-weld analogy, since arguing the tenets of the democratic process can get pretty dicey. And invariably the conversation devolves into a discussion of politics and the Constitution. Interesting and compelling, yes; but not very helpful in defending your N&V point of view.

In addition to these two analogies, I thought it would be helpful to illustrate this using a simple example to show how this works in an objective way. Consider the following fictional scenario*: We have a system that when left on its own would generate a sound level of 80 dB. As a result of our diligent, creative and clever efforts, we have employed a number of N&V countermeasures (25 to be exact), resulting in a system that has achieved the astounding

* These values are for illustrative purposes only and do not reflect an actual physical system.

sound level of 60 dB; a full 20 dB drop in sound pressure level. That's a huge change.

Here is the rub – not a single one of the countermeasures is worth more than 1.5 dB (see Figure 2). So which ones do you keep? Given the rule of thumb that 3 dB is the threshold of a perceptible difference for most humans, one could (wrongly) conclude that none of the countermeasures should be implemented. Instead, we must argue that though small on their own, all of these countermeasures are necessary. It is their cumulative effect that allowed us to achieve the 60 dB goal shown in Figure 3.

So I ask again, which ones do you keep? My first answer to this question is always: "All of them." That answer never yields a happy ending; almost always, there will be some spirited discussions and compromise from both sides. I never let go of a countermeasure or design feature proposal based solely on the challenge to produce evidence of its effect. If you let one countermeasure go simply because you cannot show its individual effect on the system, the next person in line will hear about it, and the piling-on will begin. You will be powerless to stop it. They'll say . . . "but you agreed with so-and-so that the effect of countermeasure such-and-such was not audible, and so you agreed to let it go. So why are you fighting me on countermeasure this-and-that which has even less effect and costs three times as much??" Using this logic, you will end up with *exactly zero* design features and countermeasures in your system.

My last comment on this is that despite the fact that I often jealously guard the N&V performance of the product on which I am working, I do keep the overall product in my mind and will always temper my N&V countermeasure debates with what is best for the product/customer, and not only what is best for N&V. I would rather be able to sell a slightly noisier product because it was able to pass some mandated test, than to *not* be able to sell at all a really quiet product because my insistence on quietness compromised the product's performance in that very same mandated test (which wouldn't be allowed anyway!).

In summary, I sincerely hope that your N&V development work never leads you into these very tricky debates, but if it does (and I suspect it will), I hope that these communication tools help you in defending the countermeasures and design features that you believe are needed for your system. Best of luck, and be sure to let me know if I can help. S/V

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