Microwave Bytes Back

In Defense of Uselessness

■ **James Rautio**

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I was feeling pretty good about a paper I had just presented [1] demonstrating a dynamic range exceeding 120 dB for a method of moments (MoM) electromagnetic (EM) analysis of a fairly complicated circuit. I had even taken care to point out that tiny noise ripples at 120 dB down were consistent with a numerical noise floor 155 dB down. "Pretty neat!" I thought to myself.

Then came The Question. It was from a good friend, a well-known and capable professor. He asked me privately, after the presentation, "Why would anyone ever need results with such a large dynamic range, you can't even measure that far down." Wow! I had not thought to ask that question. We engineers really like doing things that are useful. This fellow was suggesting that my work was useless. What's more, it was a reasonable and fair question to ask!

Not having considered this question before, I did not have a good answer. Within an hour, however, I had talked with an experienced filter designer. He told me that their filters are typically specified for stop-band rejection down to 80 dB. Looking at it from the analysis point of view, we typically trust results down to about 20 dB above the noise floor. A noise floor at –100 dB works nicely. Since many EM analyses cannot push any where near that far down, maybe my work might be useful after all!

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This causes me to wonder: Is the 80-dB typical stop band specification forced by measurement limitations? Perhaps. Would communication systems engineers be able to take advantage of a stop-band rejection of more than 100 dB? Maybe. Would circuit designers be able to design it? The difficulty would be increased many times with insufficient analysis dynamic range, or worse yet, unknown dynamic range.

This is an odd defense of uselessness. I spend my time searching for justification that my own work is actually useful when someone suggests it is useless. That is exactly the reason I think uselessness should be defended: We don't always see usefulness in advance. Roger Harrington related to me (as described earlier in this publication [2]) how his work on MoM was considered useless because a computer could not invert even a 100 x 100 matrix; the magnetic tape would wear out going back and forth.

Three years into my work with MoM (19 June 1986, 2:35 p.m., Meadowbrook Lodge, Blue Mountain Lake, New York), a prominent microwave designer told me that all this numerical EM stuff was useless academic research with no practical application. I clearly recall the sinking feeling I had as I realized he was right. After all, the best I could do was

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to invert a 100×100 matrix in about an hour and then only by using hand-coded assembly language. What kind of practical circuit could I do with only 100 subsections? Nothing! Maybe I should just drop all this really neat but useless EM stuff and get real. The answer is clear today: We can use lower upper decomposition (LUD) to invert $100{,}000 \times 100{,}000$ matrices in about two hours, and numerical EM is a required part of modern high-frequency design. Fortunately, I decided to ignore that early (and accurate) designation of uselessness.

In these—and many other—cases, uselessness is an accurate designation upon the start of a major piece of work. The people telling Roger Harrington that his work was useless were absolutely correct. The people saying my work was useless knew exactly what they were talking about. My work on EM dynamic range and quantitative accuracy (it is incredibly difficult to get papers published on this topic!) is also correctly described as useless, at least for now, for some people.

Why do we creators of useless research continue to work so hard? When Roger Harrington did the calculations for his classic text on EM theory [3] in the mid 1960s using an advanced, state-of-the-art electromechanical calculator, it was really neat. When I got my first MoM matrix successfully filled and inverted, it was really neat. When I saw my first analysis showing a dynamic range pushing all the way down to 180 dB, it was really neat. We do it because we love it. We do it because it is really neat. Usefulness is an afterthought.

But we are engineers; usefulness is important. If something is useless, that might be OK, as long as there is a chance, someday, that it might be useful. So we do have to keep an eye on usefulness, and if some course of our endeavors really starts to look like it will never be useful (e.g., pig perfume [4]), then it is important to be realistic, cut our losses, and get on with life. We have all had our failures, and, like losing lottery tickets, we tend not to publicize them. When we strike out, it is important to realize it as quickly as possible, shake it off, and get on with the game.

What about these people who take ideas whose greatness still lies in the future and blithely call them useless? Are these people useless, ignorant morons? I don't think so. In fact, these people are basically just like the rest of us. I'll go even further: These people are us. Any one of us can and have pointed to a future great idea and called it useless. It happens. The downside is we might kill a future great idea with our quick callous of judgment. It's like a car running down a small child; as the parents cry over the small coffin, we wonder what might have been.

When I am talking with researchers or reviewing papers, I try to drive carefully. I will never condemn a new EM analysis because it is slow or inaccurate. Someday it might grow up to be fast and accurate. However, if someone claims an analysis is fast when it is really slow, or accurate but they give no quantitative indication of error, I point it out. I always try to give the child a chance to grow and to gently but firmly direct attention to areas that need work.

As long as it feels "really neat" and there is at least some remote potential for future usefulness, let's drive carefully and refrain from using "uselessness" as a reason to discard someone's work. But perhaps some might feel this advice is itself useless. They might be correct. But I hope they will consider carefully reading this essay a second time, because it is they for whom I write.

References

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MTT-S Ombuds Officer *(continued from page 138)*

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