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Character Test

BY MIKE BUETOW

Mike Jouppi isn't a household name yet, but let's give it a few months. After all, the self-styled thermal management specialist has spent a good part of the last few years updating the printed circuit board current carrying capacity charts. And he's had the patience to see it through, despite several job changes and many lessons in governmental bureaucracy.

The original data – on which all the commercial and military specs are based – came from research conducted at the National Bureau of Standards in the mid '50s (although many thought this data came from the work of Dr. Charles Jennings at Sandia Labs in the '70s). Jouppi's findings debunk many long-held "rules." For the PCB world this is like finding Moses' third tablet. But who could have blamed him if he had given up? His is a tale of perseverance.

Jouppi conducted much of his research while at Lockheed Martin in Colorado, where he had access to the tool set needed to validate the tests. In the late '90s, while studying conductor heating parameters, he began to question whether the current carrying capacity charts – the staples of industry standards – were accurate. With the University of Colorado-Denver, he submitted in September 2000 a proposal to the National Science Foundation requesting funding to continue conductor tests on how varying amounts of voltage and current would behave under specific conditions. It was turned down for a variety of reasons, Jouppi recalls, one being that NSF thought the work had already been done. "That reviewer obviously had not read the proposal," he says now, without a trace of bitterness.

In the meantime, Lockheed cooled on the project. Undeterred – and now on his own – Jouppi approached U.S. Department of Defense ManTech Program, a joint effort to speed time-to-market of advanced weapons systems, where his proposal "fell into a crack." Next, Jouppi solicited companies participating in an industry task group that had formed on the back of his earlier work, but only one company offered help with funding. His time and money exhausted, Jouppi had to close a lab UC-Denver had set up to conduct the tests.

Yet Jouppi went on. His plan called for two phases: testing epoxy boards and polyimides and reworking the charts, then studying copper planes and vacuum environments. His first tests were on a test board similar to the ones used by Dr. Jennings in his landmark Sandia study. Jouppi later redesigned the test board using a design that was more conservative. In some cases, the differences were staggering. In one instance, using polyimide, Jouppi found that 200% more current could be run than is permitted in the IPC design standard.

One of Jouppi's original goals was to ascertain what happens to products using high current pulses followed by a low steady state. "People wanted to know what this was doing to the circuitry, what would happen under ambient conditions, [and] what the effect was on components," he says. This in turn led to questions on the impact of large numbers of internal planes and how to take advantage of the heat spreading of extra copper in the board. As many studies have shown, the standards are conservative. But another important aspect emerged, too. Jouppi found that the width of the trace – as opposed to the cross-sectional area – is a better way to look at current carrying capacity. "Depending on the weight and the width of the copper, those results can be different." The downside is that designers will have to plow through a large number of charts. Not to worry: Jouppi is now in full swing with a software company developing a tool for designers to make that job a lot easier.

Printed Circuit Design plans to publish some of his research this year. With solutions to conductor spacing and heat issues at a premium, by year-end we all may be thanking Jouppi for his foresight. Let's thank him for his determination, too.