'Is This Industry Really Necessary?'

By Harvey Miller

The National Academies organized one of its investigative programs to separate fact from fiction before a committee of unbiased experts regarding the state of the U.S. printed circuit board industry. An insider's look at what was discussed, and the action that must be taken to defend America's electronics industry.

Washington, DC—On December 13, 2004, the question, "Is this industry really necessary?" was posed to me at the end of the day by a young staff member of the House Armed Services Committee, who also works for an important Congressperson on that committee. Twelve expert presenters had discussed the crisis in the U.S. printed circuit board industry from many divergent perspectives. Ten qualified committee members from industry, academia, and the military reported to the U.S. House of Representatives on behalf of the Board on Manufacturing and Engineering Design of the National Academies regarding the following topics.

- Our PCB industry's technical competence relative to the world, present and future.
- The role of PCBs in maintaining U.S. military capability, especially in meeting unique defense needs.
- The impacts of legislation and regulation on PCB manufacturing's contribution to military capability, also on its environmental and human health effects.
- Potential strategies for R&D and PCB manufacturing to meet both legacy and future U.S. defense needs.

During that memorable day, I had observed a model technique for reaching the best advice to help our Congress decide an important issue—a requested $5 million appropriation to continue printed circuit related R&D projects under the Emerging/Critical Interconnection Technologies Program at NSWC-Crane with IPC involvement, discussed further below. The money would be included in the $450 billion Department of Defense budget.

The Presentations

The crisis in the U.S. printed circuit industry is told by one statistic. Between 2000 and 2004, production plummeted about 50%, from $9.9 billion to $5.1 billion, back to 1990 levels, when the U.S. produced 30% of world total (Ref 1.). Now it's less than 15%. Simply put, it was an economic tsunami.

The industry was victim of a double whammy. First, the collapse of the 2000 telecom bubble shocked the electronics industry. Second, the migration of electronic assembly and board fabrication to China never allowed American PCB fabricators to recover.

Two reactions to the new reality are expressed on every platform and conversation about the U.S. industry. They converged in the Washington D.C. meeting.

One opinion, held at high levels of the government's Executive branch, states "Let the chips fall where they may." The English economist David Ricardo taught us 200 years ago that "comparative advantage" should determine the location of production. His modern-day followers say further that this wisdom applies with special force to "commodities" like beer, textiles, and printed circuit boards. Why should special effort be made at governmental levels to help the U.S. industry in any way, except to retrain former employees in other more needed skills? One problem with this view is that no other major U.S. competitor believes in purist Ricardo when it comes to seeding advanced technology. Everyone knows how pro-active are the governments of Japan, China, France, Germany, etc. in fostering and supporting technology R&D.

The opposing vie—that the U.S. PCB industry is relevant and valuable—was expressed in many ways by many presenters at the meeting. For John Shawhan and Roger Smith of Warner Robins and NAVSEA Crane respectively, PCBs are not a commodity. Each is a custom, vital component that makes non-operational defense systems operational. Sometimes, lacking prints or design information, they have to reverse engineer.

Reverse Engineering the Competition

Reverse Engineering (R.E.) is a topic that deserves a special essay, but here it will receive special mention. In a brilliant presentation, Ron Thompson, formerly the builder of NAVSEA Crane PCB fabrication capabilities, now at consulting firm SAIC, told us "how to" reverse engineer PCBs. R.E .is one of the hidden secrets of technology transfer that in part explains the global pervasion of practical arts and scientific applications. There is no important company or growing country that does not practice R.E. to stay abreast of and move ahead of the competition. An

exception is the U.S. PCB fragmented industry of hard-pressed entrepreneurs. The two remaining DoD PCB facilities would be glad to help, given some funding.

R&D Vital to American Competitiveness

Richard Snogren, a veteran of the PCB small enterprise battles, was almost a victim of his bank's haste to foreclose. His company was rescued by a larger company: Coretec. He carries on the tradition of American innovation with his work on embedded passives. Someday, when cell phones are mature enough and product lives extend enough, embedded passives, replacing discretes in the interest of space and system cost saving, may give the U.S. PCB industry a proto and development role. That's my take, extendable to many other products. Materials level embedded passive technologies are an American strength being developed by DuPont, Rohm & Haas, Motorola, and others. Research and development at the fabrication level is beyond the resources of the U.S. PCB industry. But NAVSEA Crane is ready to continue its R&D, providing enormous potential advantages to U.S. defense electronics miniaturization.

The SEMATECH model is a very instructive example of the potential benefit of a U.S. government-contributing role in fostering advanced technology. It helped save the vital U.S. semiconductor industry. Dr. Darel Frear, who manages RF and Power Packaging Technology Development at Freescale Semiconductor, successor to Motorola, told the story of SEMATECH's success, 1987 to 1998, in meeting that goal. In the 1980's, the Japanese companies, aided by their government in a very non-Ricardoan manner, were beginning to dominate a critically important industry that had been conceived and born in the U.S. In December 1987, President Reagan signed for funding SEMATECH, a consortium of 14 U.S.-based semiconductor companies with the U.S. government. By 1992, the U.S. industry was number 1 again, producing 44% of total world value.

In 1998, U.S. governmental support was withdrawn and SEMATECH went international.

Dr. Hayao Nakahara, who spends most of his time traveling the globe visiting printed circuit company plants, has a unique perspective on the U.S. PCB industry. When he was 24, he wandered by bus all over the U.S. and fell in love with its diversity and openness. He has been here ever since. Now, he is a friendly critic who exhorts the U.S. industry to do better and contributes what he can to that end. He related a little illustrative, semi-humorous anecdote from Japan. Paraphrasing, 'The U.S. contributes the ideas, Japan converts them into practical manufacturable products, and then Taiwan and China take over.' Naka is telling us that theory and practice are inextricably linked. If we lose the practice—PCB fabrication—the generator of ideas is also gone.

Executive Orders

There were 19 presenters, impossible to cover adequately in this article. We'll conclude with two who made valuable contributions, born out of their executive experience in the industry. Benoit Pouliquen is President of Flextronics Flexible Circuits, formerly Sheldahl, and was president of a major U.S. printed circuit company that disappeared in 2002, when its cell phone product migrated to Asia. His pessimistic view is shaped by experience plus the reality of ten-fold reduction in labor cost in China.

Herm Reininga managed Black Box manufacturing for many years at industry leader, Rockwell Collins, on whose reliable equipment most aircraft, military and commercial depend. He compared labor cost component of box manufacture—3% to PCB fabrication in China—compared to 25% in North America. He had considered outsourcing PCBs, but the captive facility was very handy for surge requirements. And reliability is not easily outsourced.

An Insider's Take on the Problem

The Committee on Manufacturing Trends in Printed Circuit Technology's forthcoming report will encompass the four points outlined in the first paragraph, with defense needs their focus. They will answer the question 'Is U.S. PCB industry necessary for defense?'

Tom Clifford, who helps Lockheed Martin Sunnyvale acquire PCBs, put it this way in a recent letter: "Speaking as an industry observer (West Coast Editor of Printed Circuits Europe), and not as a spokesman for Lockheed Martin: Yes, there are serious concerns about the future of U.S. printed circuit technology.

Next-generation devices (new breeds of silicon and ICs, approaching molecular dimensions, packaged all 3-D, with studs and bumps and odd polymerics and alloys) arising via consumer electronics applications, will soon be the only hardware resource available. These components are certainly high-density and immensely capable, but are of problematic reliability. They will respond unpredictably to failure-modes and workmanship vulnerabilities that are profoundly alien to old chip-and wire understandings. That technology arose within a disciplined mil-spec quality infrastructure, and proven protocols of burn-ins and accelerated aging and qualifications, guided and validated by careful modeling and analysis and workmanship that created the defense weapons systems of the last several decades. All that is fast disappearing, consistent with commercial electronics 3-6 month product life cycles and planned electronic obsolescence, and the consequent irrelevance of FMEA and hi-reliability quality.

Grey-beards are retiring, and all those scary-bright newbies are drawn to the high visibility and glamour of information systems or nano-tech. And why shouldn't they? The mundane chores of circuit-board design, IC design, IC fab, assembly are being offshored, consistent with the view that electronics is a commodity like wheat or crude-oil (heard at a recent trade show: " ... they are putting assembly in the same category as the masking tape on the bottom of the shipping carton..."). This is particularly painful at a time when the distinction between board designs, package design and integrated circuit design is disappearing, and breakthrough capabilities are exponentially emerging.

Yes it is critical that the US must maintain competence and leadership in high-density, high-reliability electronics. Yes, let's add our voices to support all efforts to that end."

Raising PCB 'Consciousness'

Defense technologies and innovation-driven, market-pulled commercial product technologies have inspired and supported

How IPC came together with NSWC-Crane to Support PCB Industry R&D

In 1980 captive divisions of integrated original equipment manufacturers dominated U.S. printed circuit fabrication. R&D funding was a natural extension. By 1996, captive board fabrication by large, integrated OEMs had declined to 14% of their consumption in a steady downtrend. With OEM departure from PCB production, funding for corporate PCB R&D dried up. David Bergman, Director of Technology Transfer at the IPC, told in the lead-off presentation how the IPC tried to fill the gap. ITRI, the Interconnection Technology Research Institute was formed in 1994, to conduct and coordinate research programs. But the downturn of 2001 led to ITRI's demise and to a search for a new way to fund printed circuit R&D.

Even earlier, Ronald Thompson, who headed up the printed circuit operation at NAVSEA Crane in southwest Indiana, was talking to David Bergman about that new way. They came together on October 26, 2001 when a new PCB R&D alliance was formed out of the common need shared by defense and commercial electronics. That was the day that the IPC and the Naval Surface Warfare Center Crane signed a three-year Cooperative Research and Development Agreement and bestowed a new acronym on an unsuspecting public—CRADA. Quoting Ron Thompson, "The goal of the program is to aid PCB manufacturing by researching state-of-the-art advances in design, development and manufacturing processes. NSWC Crane has a complete PCB manufacturing facility, comprehensive failure analysis lab, an environmental test and evaluation lab and extensive computer modeling capabilities to support this goal."

Fast forward to 2004, CRADA expired, but not the need for printed circuit board R&D.

The Industry-Defense alliance was inspired, it worked. Important projects had been initiated on a total million dollar budget looking at new materials, liquid crystal and microwave substrates, for example. But Crane, like the other DOD fabrication facility, Warner Robins Air Logistic Center, already was funded for another charter—to keep all defense electronics operational, legacy and today's, ancient and modern. So the IPC and Crane perforce went back to our Congress, hat in hand, for that $5 million that we mentioned above. And that is why and when a sympathetic Defense Logistics Agency suggested, 'Why not gain more consensus and educate more people? Let the National Academies organize one of their investigative programs to bring out all the facts and opinions before a committee of unbiased experts. A report that emerges from that process commands the respect of all.' So Ronald Thompson of NAVSEA Crane and John Kania of the IPC labored for a year to make that happen. And that is why we met for two days in December in Washington D.C in the National Academies' building at 5th and F. **CT**

each other at many levels. The PCB infrastructure level provides the glue that holds commercial and military electronic equipment together. It is salutary that the crisis of this pioneering U.S. electronics industry was noted in an important .meeting in Washington D.C. two days in December, 2004. Consciousness of a problem by enough of the right people may lead to action, even if modest at first.

The Audience

Analysis of the 50+ attendees reflects the meeting's main focus, 'How vital are printed circuit technology and production capability to U.S. defense needs?' But the list also reflects an interest in a broader, complementary question, 'How vital are they to the U.S. Electronics Industry, going forward?'

Workshop on Manufacturing Trends in Printed Circuit Board Technology

December 13-14, 2004

Category	Number
DOD	10
Congressional	6
Other Governmental	3
Professional Associations	6
OEM	6
Academia	5
Trade Associations	4
Consultants	3
National Academies	3
EMS	2
PCB Fabricator	2
PCB Supplier	1
Total	**51**

Key to acronyms: Department of Defense, Original Equipment Manufacturer, Electronic Manufacturing Service, Printed Circuit Board

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References

1. IPC figures and Fabfile Online statistics.

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