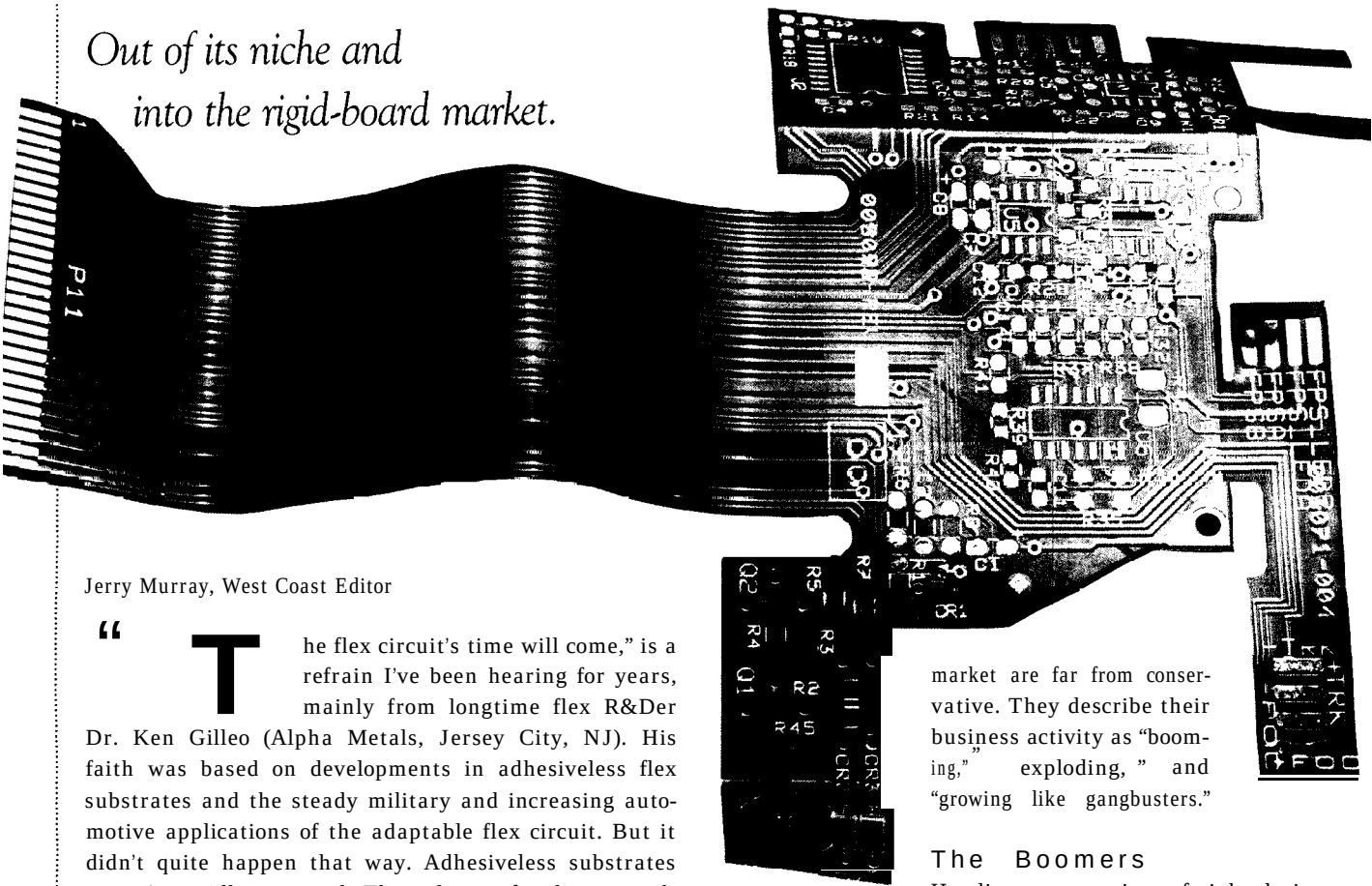
Flex Floodgate Opens

Out of its niche and into the rigid-board market.



Jerry Murray, West Coast Editor

"The flex circuit's time will come," is a refrain I've been hearing for years, mainly from longtime flex R&Der Dr. Ken Gilleo (Alpha Metals, Jersey City, NJ). His faith was based on developments in adhesiveless flex substrates and the steady military and increasing automotive applications of the adaptable flex circuit. But it didn't quite happen that way. Adhesiveless substrates weren't rapidly accepted. The volume of military work fell sharply. Automotive use of flex circuits didn't zoom. Despite these delays, the flex circuit's time has finally come.

Economic studies look favorably, if conservatively, toward the business that has traditionally accounted for about 8% of the total PCB industry market. The IPC's TMRC report, published in June, predicts that the U.S. flex market, which has held fairly steady at around $400 million per year since 1987, will increase by just 4 to 6% in 1994. A bit more optimistically, BPA (Cold Spring Harbor, NY) foresees 6 to 7% worldwide growth through 1997. BPA tempers its modest growth rate predictions by saying, "Everything is pointing upward for the $1.6-billion flex industry." And as the TMRC report explains, the 11% gain enjoyed by manufacturers of flex products for computer and communications applications more than offset the military's diminished flex purchases.

The flex manufacturers pursuing the commercial market are far from conservative. They describe their business activity as "booming," exploding," and "growing like gangbusters."

The Boomers

Heading a consortium of eight designers, assemblers, and users of flex circuits is Sheldahl (Northfield, MN), which is building a $40-million manufacturing plant in Longmont, CO. One end of the facility will manufacture Sheldahl's adhesiveless substrate, Novaclad; the other will process that substrate into Novaflex circuits. Both ends of the plant will converge on the overall goal of reducing the material and processing costs of flex circuits. Sheldahl's VP of technology, Dick Slater, says, "Cost is the only thing stopping flex from moving out of its traditional 10% market share niche and into the high-end hard-board market."

According to Program Manager Milt Werkema, Sheldahl's core technology, reel-to-reel processing, will be supplemented with newly developed equipment such as holographic phase masks for cloning an excimer laser beam into mini-beams that instantly produce "oceans of vias," and a flying-probe tester developed at IBM-Boca Raton with four probes that can handle 200 test points

per second. Financial help from the government's Advanced Research Projects Agency is going into the vertically structured consortium. The group's four major users of flex circuitry—Delco Electronics, Silicon Graphics, Hughes Missile Systems Co. and Wireless Access—are eagerly awaiting the completion of Sheldahl's 3-ft./minute production line.

Slater feels that Sheldahl's consortium will result in a reduction in cost of flex circuitry. He explains, "Lowering costs will certainly open new doors for flex boards, as in the entire multichip module market. It will also show that there isn't that much difference between very thin cores and films. Some people are processing very thin rigid materials reel-to-reel, and we'll be mass producing our Novaclad into multilayer products very much like hard boards in terms of appearance and component mounting. "

Parlex Corp. (Methuen, MA) survived its cutback on 90% military dependency in 1988 and is now realizing $35 million in sales per year. Growth is resurging in the firm's automotive, computer, and telecom applications. Long known for its technical innovations, Parlex manufactures its own substrate (PALflex) and produces flex multilayer boards of up to 30 layers. According to President Herb Pollack, the firm is now being granted patents on "a method of making flex multilayer boards, with an emphasis on the four- to six-layer marketplace, which will cost but a small premium over rigid multilayer boards.

"Adhesiveless," Pollack continues, "is at the heart of our development programs. We're already shipping volumes of our current generation of automotive products, which are double-sided adhesiveness circuits with liquid photoimageable material or dry-film photoimageable polyimide as coverlay. And the PCMCIA market is certainly a target for our new technology. "

AdFlex Solutions Inc. (Chandler, AZ) has pursued neither the PCMCIA nor the MCM market. "We're too busy with what we do," says Gary Bechler, the company's business unit manager. What the company dots is supply the notebook computer, workstation, and disk drive industries with circuits built to survive up to 10-million flexure cycles. The products' lines, spaces, and holes are constantly shrinking because, says Bechler, "The disk drive industry transitioned from 5.25" to 3.5"; now they're heading for 2.5", with 1.8" disk drives on the way. Think of the circuitry that goes into them!" AdFlex gets technical help from the suppliers of its standard and adhesiveness substrate vendors, especially from Rogers Corp. (Chandler, AZ), the company's former owner.

Ampersand is the Boston-based venture capital company that bought Rogers' flex circuit fabricating operations in June 1993. As Steve Lockard, AdFIex's VP of marketing and business development, says, "The flex business is booming! We're going full-bore, with excellent sales growth and profit. We're shipping hundreds of thousands of flex circuits for dynamic disk drives to Smartflex (Tustin, CA) and Solectron (Milpitas, CA) for direct chip attachment. These are chip-on-flex applications. For our notebook customers, we're connecting to LCDs by going through a hinge that has to survive tens of thousands of flex cycles, while at the same time providing EMI shielding. We're into some interesting packaging problems. This is a challenging industry right now, and it's still in the fundamentals of what flex can do."

Merix Corp. (Forest Grove, OR) is a medium- to high-volume producer of high-end flex products. In addition to building flex circuits, Merix engineers John Woodyard and Doug Troubough are in close touch with the company's rigid-board operations. "Aspects of flex can be incorporated in rigid technology and vice versa, " they point out. "Several materials are converging into this area. Flat and nonwoven glass thin-core materials aren't defined as flex substrates, but with their high flexibility and very smooth surface they provide many of the flex advantages and characteristics at half the cost of flex. When you're working with thin materials, it's a matter of what substrate has the right properties and economics for your application. "

Five years ago, M-Flex (Fullerton, CA) was primarily a military supplier; two years ago it was not listed as a flex supplier in the IPC's TMRC report. Today, the company is turning out $35 million worth of flex circuits per year, and is well into the real estate stages of building another flex fabrication plant in China. Most of M-Flex's products, says Marketing Director Gabe Sanchez, are for computers and their peripherals, with an emphasis on PCMCIA cards, ". . . because our yields are higher than those of rigid-made PCMCIAs." Company President Phil Harding attributes the firm's growth to solid pre-engineering and the new plant in China to good relations on each side of the Pacific Rim. While hard-board manufacturers moan about Far Eastern competition, 30 to 40% of the Fullerton plant's output is exported to Asia.

According to CEO Ray Ianetta at Poly-Flex Circuits Inc. (Cranston, RI), the flex business is burgeoning on the Atlantic Rim as well. Part of Cookson Group's extensive electronics operations, Poly-Flex recently doubled the size of its U.S. operations while simultaneously opening a 34,000-sq.-ft. facility in the United Kingdom. Both plants manufacture a unique variation of flex that consists of a dry process incorporating a polymer thick-film process to build circuitry and a conductive adhesive called Poly Solder to attach active components to Poly-Flex's customers' products. No wet processing is used to create the circuits, which can be bent around a 1/4" mandrel without losing components. The process produces 3-mil lines, is capable of handling 10-mil pitch, and can include bare die attachment on polyester or polyimide substrates. "We're less expensive than copper on Kapton and we can make 12-layer

MLBs," says Ianetta. "With cost savings in the area of 30 to 70%, we're competing with the traditional flex manufacturers and the rigid-board industry. " In two more years, Ianetta added, Poly-Flex will be manufacturing and competing in Asia.

Feeding the Boom

The suppliers to the flex industry are keeping ahead of the flood. DuPont (Wilmington, DE) plans to continue to serve as the largest worldwide supplier of polyimide film (Kapton), and is adding a fourth product to its Pyralux line of flex materials. Pyralux PC, a flexible photoimageable coverlay, is designed to enhance resolution and productivity. Rogers' R/flex family of flex materials now includes over a dozen members and is growing. Coates ASI (Phoenix, AZ) is reportedly manufacturing large quantities of Aquaflex H20/600, an aqueous LPISM developed as an environmentally friendly solder mask, and found to be especially suitable for use with flex. Nanticoke Micromachining (Nanticoke, PA) is making machines that gang-punch l-roil holes for flex manufacturers.

The strategic alliance of Nelco (Chandler, AZ) and Gould Technical Center (Eastlake, OH) brings a new adhesiveless material system into the flex arena. Gould's newest electrodeposited copper, said to be very fine-grained and highly ductile, and Nelco's specially formulated polyimide forms Nelflex, a substrate whose peel strength and other characteristics have exceeded the strategic allies' expectations. These substantial suppliers to the electronics industry will shortly announce other products for the printed circuit board market segment that Tom Saven, Nelflex's marketing manager, predicts will enjoy double-digit growth for the next five years.

Conclusion

M-Flex's Phil Harding believes the rigid and flex industries are indeed merging. "We're not in the flex business," he reflects. "We're in the thin laminate business. We use rigid techniques on flex materials to build PCMCIAs. And we've made parts with both rigid and flex materials in them. Why not? It's easier for a flex house to use rigid techniques than vice versa. Problems with shrinkage, dimensional stability, handling—we have those under control. Strategic alliances between the two industries are bound to occur. We're thinking about becoming a mass laminator for the rigid industry because we can make thin-core products better than it can. The rigid industry has problems handling 3-mil cores, which to us are very thick. Although we'll never compete with the traditional rigid board, there'll be many areas in which the two industries will become one. "

Rumors of rigid-board manufacturers building or acquiring flex facilities are rife. DuPont's John Lind, development manager for flex circuits, analyzes the business possibilities this way: "The flex houses certainly know how to handle today's flimsy materials, but it's the rigid houses that know how to handle enormous output. Strategic alliances are already being formed, with the flex people supplying the know-how and the rigid folks providing the capacity."

Alpha Metals' Ken Gilleo summarizes the state of the flex circuit industry: "Finally, people are seeing they can use flex circuits to make ultrathin MLBs with little tiny holes and very good heat transfer capabilities. And flex can be semi-additively processed. It's about time flex caught on. "

Flex is doing more than catching on. Freed from the military's staid requirements, and with adhesiveless substrates at last a reality, the flex circuit looms as the long-awaited interconnect technology of the future. FAB

Bibliography

Gilleo, Ken. Handbook *of Flexible Circuits* Van Nostrand Reinhold, New York, 1992.

Photo on page 16 shows optical disk drive circuit constructed of PALflex, courtesy of Parlex Corp., Methuen, MA.