Silicon Valley: Valley of Innovation or Valley of Death?

Can emerging technology products continue to cross the chasm from prototype to production without dying a slow and painful death?

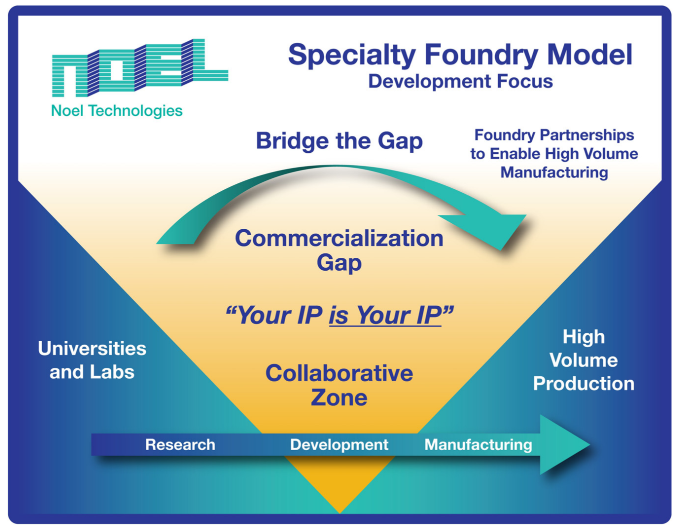
By Keith Best, Noel Technologies, Director of Photolithography

Since 1957 when eight scientists at Shockley Semiconductor left to form Fairchild, Silicon Valley has been the hub of innovation and the incubator of technology companies. Product ideas for integrated circuits (IC) sprouted like California wildflowers and the path to building companies to manufacture those products was as unimpeded as the original freeways that intersected the valley. But as IC manufacturing gradually moved offshore, the path to producing "more than Moore" devices for new applications is now often a slow and painful march toward failure. The new product ideas in prototype are solid; the path to manufacturing is typically the chasm that spells death to many a good idea. Has Silicon Valley become the Valley of Death for technology products?

Once the strength of the Valley, company R&D labs employed the best and the brightest and those employees gathered and grew a wealth of process and product knowledge. These enterprising engineers and scientists developed new products and had the infrastructure and supply chains present, usually located in the Valley itself, to take those ideas to the manufacturing floor. The results were products that not only satisfied a customer's need but also often exceeded expectations and requirements. Now new companies in Silicon Valley often have similar creative ideas for products in ICs as well as other emerging technologies including thin film batteries, solar cells, energy scavenging, lab on chip, LED, clean technology, and more, but the path to scalability is not so clear.

Back in the 1980s, SEMATECH tried to fill that vacuum. Stocked with equipment and engineers, the Austin, Texas, fab tried to make U.S. IC makers competitive on a global scale. Recently, Silicon Valley Technology Center (SVTC) had a similar business model: use our equipment, develop your process, and then take that process to production. The demise of SVTC last year may have been the deathblow to the Valley's path to scalability of new product ideas.

Many new companies rely on a small team of engineers to develop a product concept. But these engineers rarely have the knowledge base to take that concept into a lab environment to produce the end product ready for volume production. If these new companies are venture funded, the capital usually runs out before the product is produced. Thus, the product dies in the valley between concept and production. (See chart).



One reason this process between concept and production is failing is the proliferation of different products and processes. When CMOS, memory and other silicon-based products were being developed, there was a network of smaller companies built around bringing those processes to production. Mask shops, chemical suppliers, lithography vendors and others in the supply chain were all located in the Valley and would contribute to helping the design reach maturation. This network often had talented process engineers on staff to solve problems and offer solutions. Many silicon-based IC products had similar processes and this knowledge was shared without giving away company IP. Now process requirements are much broader, the talent pool in the Valley is much smaller and many of the unique vendors have disappeared entirely. With the business models within technology changing and the emergence of foundries as major manufacturers of multiple products for many companies, it's now a long march across a valley of technology to scalability. Many don't make it. Like a long trek across a desert, without the life-giving water, in this case money, ideas just dry up and blow away.

Niche products that have unique processes and materials have heightened risk models associated with manufacturing. They often need solutions that cover everything from design through fabrication, test and packaging. These new processes can include:

- lithography on both sides of the substrates,
- imaging of thick photoresist films for high aspect ratio plating structures
- and processing with new materials such as piezoelectric, III-V compounds, glass, and magnetic.

Many of these processes are not on the ITRS roadmap. Furthermore, the new substrates run the gamut from transparent to thin to flexible to perforated which add another degree of complexity to the already challenging task.

The business models for the different ways to get a product from concept to product also vary and many have costly downsides. The university model offers a low cost solution, but typically the time to market is slow and mostly focuses on proof of concept where the IP generated is shared between the researcher, student and professor. Sometimes captive fabs offer these development services. In this model the company retains its IP and the effort is collaborative, but the cost is high and the time to market, although fast, may not be available at all because of limited manufacturing space at the fab. The large foundry model offers a low initial cost for high volume projects and an intermediate time to market, but the downside includes shared IP and a very selective process to qualify for the volumes needed to manufacture. Also, small lots are typically cost prohibitive. (See table 1).

Model	Cost	Time to Market	IP Ownership	Collaboration
IDMs	Low	Intermediate	Negotiated	Yes
University Labs	Low	Proof of concept	Typically shared	Yes
SMEs (Noel Technologies)	Low	Fast	"Your IP is your IP"	Yes
Captive Foundry	High	Fast, restricted to mainstream	Company	Selective

Table 1.

But a new model is emerging. It may offer the life-giving water to thirsty products crossing the chasm from prototype to production. The water is there for the taking but it's often hard to reach. In California, four university labs are stepping into the breech with focused nano-labs and tooling to build manufacturable products. Stanford University, the University of California at Berkeley, UCLA and UCSB (Santa Barbara) will give access for design scientists to build their product ideas to proof of concept. In the past, these universities and others scattered around the U.S. ran independent labs developing products for new applications. The four California universities may not have state-of-the-art tooling but what they have is very relevant, scalable, and they provide access to industry.

For more information on these four labs and their capabilities, visit their websites:

UCSB http://www.nanotech.ucsb.edu/
Stanford: http://snf.stanford.edu/
UC Berkeley: http://nanolab.berkeley.edu/
UCLA: http://www.isnc.cnsi.ucla.edu/

The problem, however, is that access is only half the battle. Typically university labs only offer basic training and tool time on the equipment and for a small team of design scientists to try to build a scalable prototype, the knowledge base required to run a myriad of process equipment for a new application is not easy to obtain.

But there is an oasis in this valley death march. Small specialty foundries partnering with universities can provide the engineering resources, processing expertise, years of experience, and equipment to help new products reach the other side. They can provide a method to process a product, scale it up, and produce a blueprint to take that product to a larger foundry like Globalfoundries or TSMC for volume manufacturing.

Many specialty foundries have built their business reputation by being flexible and diverse. They typically work with wafers from 50mm to 300mm of different shapes including squares and pieces. They have flexibility in the substrate materials they process including silicon but also sapphire, glass, and others. And many offer a multitude of process parameters including lithography, thin films, LPCVD, PECVD, metals, wet etches and cleaning processes. They made their mark working with many different products and can offer ideas and suggestions to get those products to production more quickly and efficiently. Many are ISO certified, provide Class 100 cleanrooms, and have unique and tested quality tracking systems to guarantee process duplication, ready for scale up.

Innovation has always been the hallmark of Silicon Valley. The metamorphosis from Shockley Semiconductor through the heyday of the 1980s and 1990s until today's changing landscape follows a determined path to make technology devices smaller, faster, and more powerful. When large U.S. manufacturers left the Valley, jobs dwindled too. But now resurgence in technology ideas and products and a path to producing these ideas efficiently in a timely manner may lead to a renewed vigor in the Valley. Specialty foundries are one solution that can help bridge the gap from research to manufacturing and avoid the death of great products. Keeping manufacturing and jobs in the Valley may just be icing on the cake.

About the Author:

Keith Best is the Director of Lithography at Noel Technologies. Best joined Noel from Simax Lithography, an engineering services company that optimized lithography equipment, where he was vice president, applications. Prior to Simax, he spent 11 years at ASML, most recently as director of application development, and also worked for LSI Logic and KLA-Tencor. With both a fab and tool background, Best has been charged with supporting and expanding Noel's existing lithography engineering services and setting a roadmap to take lithography resolution down to 0.15 microns.

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