This successful Executive Summary was submitted in the 1998 MIT $50K Entrepreneurship Competition. The SiliconTest team has graciously allowed its use as an example for teams entering the MIT $50K. The MIT $50K Organizing Team thanks SiliconTest and its members for allowing the use of this document.

# SiliconTest

## Executive Summary

### Company

We provide silicon micromachined probes for automatic testing of semiconductor chips. This new technology is far cheaper and more versatile than the metal probes currently used for this application. Our goal is to address the following challenge that the National Technology Roadmap for Semiconductors (1997 Edition) developed by SEMATECH has articulated. Describing probes as a "difficult challenge" over the next 8 years, SEMATECH says,

> ***"A major roadblock will be the need for high frequency, high pin-count probes and test sockets: research and development is urgently needed in this area."***

SiliconTest was founded in February 1998 by Rohini Chakravarthy, an MBA student at MIT's Sloan School of Management and Arvind Purushotham, a Program Manager at Intel. The idea has roots in Arvind's Master's thesis work and the exposure he has gained to the semiconductor industry while working at Intel. Arvind is the President and CEO of SiliconTest and Rohini, the Vice-President of Marketing and Sales.

Soon after we founded the company, we spoke to and convinced William (Bill) Huffman about joining us as the Vice-President of Engineering. Bill has worked at Intel Corporation for over 14 years in several positions relating to the test and interconnect of silicon and packaging. In addition, he has several professional publications and an U.S. patent to his credit.

SiliconTest strives to be a customer-oriented supplier of probe cards for testing semiconductor chips. Our main customers will be large semiconductor manufacturers such as Intel, Motorola, AMD, National Semiconductor etc. Since we plan to replace metallic probes that are currently in use, we will design our probe cards to be drop-in replacements into the existing test infrastructure. We have interviewed two key customers to elicit their response to this business idea, and are happy to report that both were extremely positive. Further, we believe that the design and packaging of this product are patent-worthy and are currently talking to patent attorneys about this matter.

### Product

SiliconTest's first product is a silicon-micromachined probe that will replace metallic probes in semiconductor chip testing. Silicon micromachining is one set of techniques within a wider technology called Micro Electro Mechanical Systems (MEMS).

**MEMS**: Silicon is the underlying material for most of the microelectronics (chips) produced today. These chips use the electrical properties of silicon. However, silicon is also a very good mechanical material and lends itself to the fabrication of 3-dimensional structures (beams, bridges, gears etc.) with dimensions of the order of microns. MEMS is the underlying technology that is used to achieve these structures. One advantage of using MEMS is that it is possible to use processes that are very similar to the processes for producing silicon chips.

**Chip testing process**: Semiconductor testing of chips is required at various stages during the fabrication process. Each IC must be individually tested in wafer and in packaged form to ensure that it functions as intended. As chips become increasingly powerful and complex, the need for high-speed and accurate testing becomes more important than ever.

The process of testing individual chips in wafer form is referred to as wafer probing. Wafer probing establishes a temporary electrical contact between the chip and the automatic test equipment. This is the critical test for design and performance of the IC, and for sorting ICs before separation and costly packaging. A probing system, which transmits electrical signals to the wafer and analyzes the signals upon their return, consists of an Automatic Test Equipment (ATE) that transmits inputs to the chip under test via a probe. The testing is done while the chips are on one wafer – the wafer is mounted on a wafer prober that moves to align each individual chip with the probes.

**SiliconTest Probes**: Each pad on the chip is only a few microns in width and pads are 60 – 100 microns apart. Currently, the probes used to connect to the chips are precision-machined metallic ones and, given the tight specifications, are extremely expensive to produce. The prices for these traditional probes vary from $500 for the simplest ones to $120,000 each for the most complex chips. SiliconTest proposes to make probes for the higher end of this market using MEMS technology. The basic structure will be a set of cantilever beams on silicon, with metal deposited on top to make electrical contact with the pads. Since we use silicon processing, once we go down the learning curve on this technology, we expect costs to be of the order of a few 100 dollars per probe. This technology is inherently scalable: since we define our probe needles within the same process as the pads themselves, we can make them as thin as the pads become.

## Competitive Advantage

Our competitive advantage over traditional probes can be classified along four dimensions:
***Design*** – SiliconTest probes can scale up to much higher pin counts and test frequencies than traditional probes. Since silicon real estate is the single biggest cost driver for chips, IC manufacturers are constantly pushing towards high pin counts and will be willing to pay for this functionality.
***Cost*** – since we use silicon processing, we have a significant cost advantage over traditional probes.
***Turn-around time*** – our CAD systems and manufacturing model allows us to design and manufacture probe cards in 3 weeks, compared to 8-12 weeks for traditional probes and
***Reorders*** –we will provide an easy interface for reordering probes from archives and will guarantee the same quick turn-around time.

## Target Market and projections

The probe market worldwide is estimated (by VLSI Research Inc) at $450 million and is expected to grow at 25% over the next three years and settle down to 15% over the longer-term. We estimate that about 70% of this market (in revenue terms) consists of high pin-count, high frequency probe card users who will value the advantages of SiliconTest probes and pay for the design superiority and scalability we offer. In the long run, we believe that this technology will completely replace traditional precision machining. We expect to take 50% of the total market (about 70% of the high-end market).
Assuming a more conservative annual growth rate of 10%, this market will be worth $800 million in 2003. Our expectation is that after a relatively slow start (starting with 3% market share in Year 2), we will ramp up to 50% of that market or $400 million in revenues by 2003.
The probe card industry is highly fragmented. The technology is fairly homogenized, with all the major players using precision machining and some proprietary packaging. Consequently, their success seems to correlate with their ability to scale up to ever-increasing pin counts and test frequencies and their service record with their customers. The big players are CerProbe Inc., Cascade Microtech and Tokyo Cathode Laboratories.

## Business Model

**Marketing and Sales strategy**: Our marketing strategy focuses on emphasizing the superiority of the product and using pricing as an additional carrot to help customers switch to us. The pricing is two-tiered, involving a non-recurring expense to cover the overhead for custom-designing parts and a per probe charge. Typically, probes last for about 300,000 touchdowns (the probe contacting the chip); we will charge about half the price per touchdown as traditional probe manufacturers do. Our research has shown that this package of product and price will be sufficient incentive for customers to switch to SiliconTest. Promotions for SiliconTest will come from trade show presence and from customer recommendations.
In this industry, service is extremely important and customers are willing to pay significant premiums to suppliers who are reliable, quick and ensure high quality products. Further, the qualification process for suppliers is long and arduous and involves significant investments of time and effort by the customer and by SiliconTest. To meet this customer requirement, we plan to use a direct sales force to acquire customers and to employ account managers to work with customers as partners in resolving day-to-day technological issues.
**Operations**: The initial setup for the office, workstation etc. is fairly mundane. The interesting part is our manufacturing model. We have identified a foundry called MCNC that will manufacture prototypes and production quantities of MEMS structures. We believe this allows us to keep expenditures low at the start of this venture. The first set of prototypes will be designed with a specific chip in mind. We are working on obtaining this chip design

under a non-disclosure agreement – this will be a major accomplishment, providing us with our first qualification opportunity. We expect that pending the success of our prototypes, this will be our initial sale as well.
In addition to the probe manufacture, we plan to outsource the manufacture of printed circuit boards on which we will mount the probe structure. As we develop these manufacturing relationships, we will keep scalability in mind – can this contract manufacturer scale up at the same rate as we are planning to? Finally, we propose to develop an information system (CAD tools, databases etc) that will allow us to support quick turn-around times and easy reordering.

## Future staff

We have already recruited two MEMS engineers who will help us develop prototypes. Arvind and Bill and these two engineers will come on board full-time as soon as we secure funding. Rohini will work part-time until June 1999, when she finishes her MBA at Sloan. We propose to hire an experienced sales executive 6 months after we obtain funding. This person will be responsible for acquiring new customers and extending to multiple product lines with an existing customer. In the second year of operation, we will hire an account manager to take over the day-today maintenance of our first customer. We will also need one more electrical engineer and a full-time systems administrator. In year 3, we ramp up our sales group with 3 additions and match this with 3 additional account managers. On the engineering side, we will hire an electrical/ mechanical engineer and a CAD layout expert to streamline the design and development process.

## Financial Analysis

We are requesting funding for development of prototypes and business development. We estimate that the yearlong gestation period for developing and qualifying prototypes will require an outlay of ***$1.3 million***. In our second year, we expect to spend $7.6 million, based on revenues of $16 million. Our expectation is that due to timing differences in cash inflows and outflows, we will need about ***$1.5 million*** to sustain the company through Year 2. From year 3 onwards, we hope to finance ourselves entirely on retained earnings.