

DNA, Cells, Proteins + Semiconductor Technology = life science innovation on fast forward



The first draft of the human genome was declared complete in the year 2000.

The 10 year, \$3 Billion effort was funded by the United States Department of Energy and carried out collaboratively by large academic genome centers. The goal of this effort was to provide life science researchers with a complete sequence of the human genome to enable advances in the understanding of molecular biology which would be used to create the means to eventually cure basic natural defects found and improve human life.

The process by which the human genome was decoded was through the implementation of genome centers. These centers were equipped with rows and rows of capillary electrophoresis sequencers instruments working in conjunction with liquid handling robots running 24/7 decoding a single human being's 3 billion base pair sequence of A's, T's, C's, and G's. This \$3B effort provided the world with the first "reference" human genome and as it turns out the human genome is approximately 99.9% the same but the differences in that 0.1% give rise to the large variations in the human population from physical characteristics to susceptibility or predisposition of diseases.

Looking beyond the human genome there is the need to decode the genomes of plants, animals, and other organisms that are commercially vital or ecologically critical to the life cycles.

Next generation sequencing

Fast forward 10 years to today and life science companies like Illumina, Life Technologies, Pacific Biosciences, Complete Genomics, and Roche have leveraged semiconductor technology and processes to develop "Next Generation Sequencing" instrument platforms. The development of these instrument platforms leverage the ongoing advances in semiconductor processes to gain the advantages of highly reproducible microstructures that can be patterned or arrayed into silicon or glass and in some cases leveraging sensing electronics directly in the same "chip" eliminating the need for expensive optics and discrete sensing systems. The culmination of advances in chemistry, sensors and microfluidic/MEMS technology has fueled the continued drive to decreasing sequencing costs with the current goal of \$1000 per human genome set by the X-Prize for Genomics and the reduction in sequencing time to approximately several weeks. The realization of this goal will likely be achieved in the next year and will continue to drive the adoption of next generation sequencing platforms by researchers around the world.

Bridging the Gap

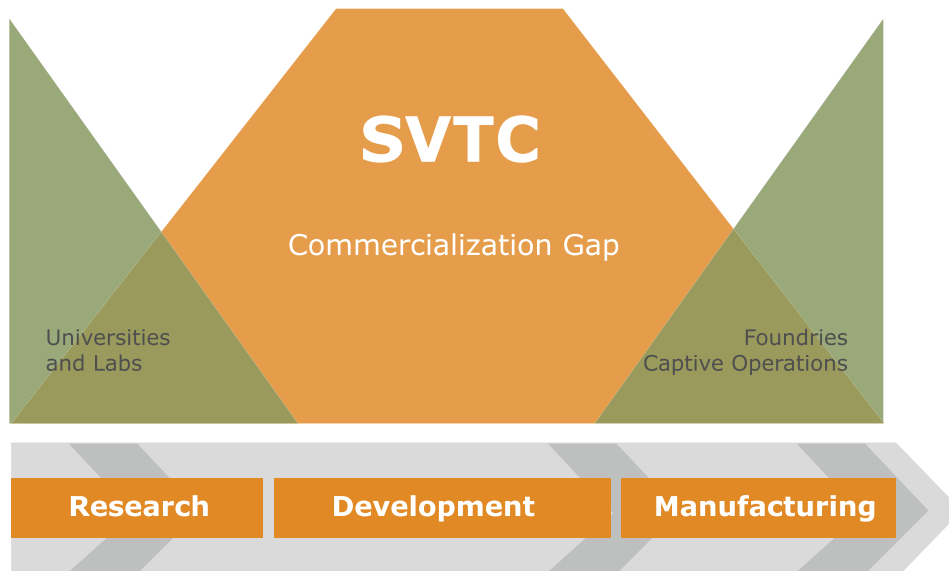


Figure 1 - Bridging the Lab to Fab Commercialization Gap

Innovation on fast forward

The use of semiconductor technologies has had a dramatic effect on Next Generation Sequencing. It has sparked a race in the life science tools industry where the decreases in cost and increases in data output has exceeded that of Moore's Law. Innovation continues to be driven in the sequence space as nanopore sequencing that is being developed will be the "next" Next Generation Sequencing and this will also leverage and push semiconductor technology from both the process and detection/sensing perspectives. Nanopores on the order of 1-3nm will need to be arrayed and instrumented on CMOS to detect the nucleic acid bases passing through the nanopores. The resulting "chip" that will ultimately be commercialized will revolutionize the sequencing market.

As the world of sequencing has been placed in fast forward, the same semiconductor technologies and processes are already being applied to the protein, high content screening, and drug delivery markets. These markets will likely see similar gains thus advancing the research and applications that will benefit the life science market.

Lab to fab

Innovations that are developing these "next generation" platforms typically come from internal company research groups or university labs. As development moves forward and a proof concept is achieved the next steps are to make the move from "Lab to Fab." From the perspective of developing the microfluidic/MEMS chip the requirements typically cannot be met with standard fabrication processes of CMOS fabs. SVTC is a nanotechnology development services company that is uniquely positioned to help bridge the gap to commercialization (Fig. 1) and has been helping our customers move from the "Lab to the Fab" since the company was founded in 2004. An advanced technology and secure IP infrastructure combined with 24/7 state-of-the-art production capabilities to support companies that are developing novel microfluidic, MEMS, and semiconductor devices for the Life Science, Aerospace and Defense, Semiconductor markets. SVTC provides access to over 250 production ready semiconductor tools in over 95,000 square feet of clean room space and process libraries with over 2500 recipes on 200mm wafers. SVTC's engineering services provides access to a highly skilled and experienced engineering team to support development from prototype to production and work collaboratively with our customers as an extension of their own teams. The SVTC development model is designed to support unique materials and advanced lithographic processes and long with a very flexible engagement model that enables rapid product commercialization while enabling customer intellectual property independence.

www.svtc.com

Michael Lee – Director of Marketing, Life Science

Michael Lee studied Electrical Engineering at Carnegie Mellon University and completed his SMEE at the Massachusetts Institute of Technology. Michael has held various engineering and marketing roles at Polaroid

Medical Imaging Systems, Actel, Mentor Graphics, and most recently at Fluidigm Corporation where he was managing all of the marketing efforts for the BioMark™ Genetic Analysis System. In 2010 Michael joined SVTC Technologies as the Director of Marketing, Life Science.