

## **SUNY College of Nanoscale Science and Engineering**

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As science advances, new academic disciplines are created. The creation of new disciplines partly reflect conceptual changes in scientific thought brought about by new discoveries, and partly reflect the practical changes in the industrial economy triggered by the discoveries. For example, advances in basic chemistry in the 18<sup>th</sup> and 19<sup>th</sup> century led to the development of a flourishing chemical industry. The new requirements of the rapidly growing chemical industry resulted in a growth in demand for further research, and for personnel trained in this area, and led to the establishment of chemical engineering as an academic discipline. In a similar vein, advances in basic science in the last two decades of the twentieth century provided capabilities to scientists and engineers to manipulate matter at dimensions of a few nanometers, and this scientific ability has in turn opened up opportunities in many industries ranging from electronics to drugs. The new opportunities have led to a rapid increase in the demand for further innovation and for personnel trained in this field, and have been the driving force behind the establishment of the new academic disciplines of Nanoscience and Nanoengineering, and the formation of the SUNY College of Nanoscale Science and Engineering (CNSE). The establishment of SUNY CNSE thus traces time honored mechanisms that have led to new educational institutions and academic disciplines as the outcome of the symbiotic relationship between science and industry.

The origin of SUNY CNSE can be traced to the establishment by New York State of a series of Centers of Excellence across the state. In 2001, a Center of Excellence in Nanoelectronics and Nanotechnology (CENN) was established at the University at Albany. When it was established, the CENN used state funding to develop research infrastructure such as nanoscale lab space and equipment. Using \$50 million in funding from the New York State Government and \$100 million from an industrial partner, IBM, a state of the art 200mm/300mm clean room facility was constructed for performing R&D in nanoelectronics. In parallel with CENN, the School of Nanoscale Science and Engineering was also established at University at Albany in 2001 with the intent of providing graduate education in Nanoscience and Nanoengineering. In 2004, the College of Nanoscale Science and Engineering was established, which has since then awarded 174 graduate degrees in Nanoscience and Nanoengineering. In 2010, CNSE became the world's first college to offer undergraduate degree programs in Nanoscale Science and Nanoscale Engineering.

From its beginning as CENN in 2001, CNSE has strived to extend the history of active collaboration between academia and industry. There are over 300 industrial partners at CNSE, from across the country and the world, many of them operating on-campus research labs where they conduct R&D on next generation technology. These industrial partners include IBM, Applied Materials, Lam Research and Tokyo Electron. During the initial years of the CNSE, seed investment offered by New York State was integral to attracting industrial partners to collaborate on basic research conducted at CNSE. As time passed and the critical mass of industrial partners grew, CNSE was able to attract partners and industrial R&D funding with less investment. The collaboration of CNSE with industrial partners have resulted in substantial investments by the partners in support of research and educational missions of CNSE, both by

providing R&D equipment and by facilitating collaboration of R&D scientists at these firms with faculty and students at CNSE.

A defining feature of curriculum at SUNY CNSE is its multidisciplinary nature. The field of nanotechnology is inherently multidisciplinary, drawing on and creating developments in traditional fields such as physics, chemistry, biology, materials science, and electrical engineering. There are four constellations in CNSE - Nanoscience, Nanoengineering, Nanobioscience and Nanoeconomics - and graduate and undergraduate students are encouraged to take courses across the four constellations. Discussions among faculty or graduate students turn into interdisciplinary projects bringing in an exchange of ideas from across the traditional disciplines. Graduate students in Nanoscience, Nanoengineering and Nanobioscience partner with those from Nanoeconomics to bring laboratory results to the market through startup companies.

Students also interact closely with industrial partners when conducting their research projects. Many graduate students complete paid internships with industrial partners over the course of their education. The internships and other interactions with onsite-companies benefit the students immensely, not only in terms of complementing the resources they have available for research but also for future employment opportunities at these companies. The industrial partners also award many scholarships to CNSE students, the IBM Fellowship and LAM Scholarship are two examples.

In addition to undergraduate and graduate education, CNSE has also partnered with local community colleges to provide nanotechnology related vocational training at these colleges. For example, the Semiconductor Manufacturing Technology program at the Hudson Valley Community College, developed in partnership with CNSE, prepares students for careers in the semiconductor manufacturing industry. CNSE has also been assisting school districts in the implementation of programs that encourage science awareness in grades K-12. In 2006, CNSE started the NanoHigh program to develop and implement innovative science and engineering education programs at Albany High School. Under the program, qualified Albany High School students receive fellowships to participate in nanotechnology-related science and engineering programs at CNSE. Since its inception, almost 100 Albany High School students have received certificates for successful completion of the program. Another highlight of the school level interaction is the annual NanoCareer Day when middle-school and high-school students are introduced to the world of nanotechnology through tours, presentations and hands-on activities. To encourage young women to pursue careers in nanotechnology, CNSE launched the CNSE-Girls Inc. Eureka!® program, where program participants take part in an intensive four-week summer camp involving a number of hands-on activities that explore advanced nanoscience concepts and applications. Nearly 60 girls participated in the second year of the CNSE-Girls Inc. Eureka!® program in 2013. The educational reach of CNSE will be further enhanced with the arrival of Tech Valley High School on campus in Fall 2014, and the Children's Museum of Science and Technology in 2015.

In addition to the creation of basic science and technology, CNSE also actively facilitates taking this innovation to next level in the market, in keeping with the vision outlined in "SUNY and the Entrepreneurial Century". CNSE plays an active role in transferring the technology developed through research to the market through its in-house technology incubators and entrepreneurship

classes. A highlight of the activities to support student entrepreneurship is the annual New York Business Plan Competition where college students from across New York converge at CNSE to pitch their ideas for new startup companies, to a panel of judges comprising venture capitalists and investment bankers. Since 2010, over 570 student teams from almost 60 of New York's colleges and universities have pitched their ideas and ventures at the business plan competition. CNSE has also partnered with Albany Law School to start a joint educational program eNTEL, to prepare student entrepreneurs to launch startup companies.

The research and educational collaborative activities of CNSE also extend to other regions, through a number of centers established across upstate New York. CNSE manages and supports Solar Energy Development Center in Halfmoon, the Computer Chip Commercialization Center (QUAD-C) in Utica, the Smart System Technology & Commercialization Center (STC) located outside Rochester, Photovoltaic Manufacturing and Technology Development Facility (CNSE MDF) in Rochester, and the CNSE-AMRI Innovation and Commercialization Ecosystem (CAICE) located at the Buffalo Niagara Medical Campus in Buffalo. These extend the nanotechnology related research and educational activities into the fields of clean energy and healthcare, among others.

The programs undertaken at CNSE have won wide support from many quarters, with Apple co-founder Steve Wozniak remarking that "if I was in college, this is where I would want to go to school". President Obama on his visit to the campus, applauded the CNSE model, "You have an outstanding university. Now I want what is happening in Albany to happen across the country". To facilitate the growth of CNSE, SUNY Board of Trustees passed a statute in 2014 elevating CNSE to a new college under the SUNY system. The establishment of nanotechnology related industrial facility at Marcy in Utica, has led to a close collaboration between CNSE and SUNY IT at Utica. The collaboration was formalized by the SUNY Board of Trustees with a statute for the formation of a combined institution.

CNSE has traveled far since its beginnings in the Center of Excellence in Nanoelectronics and Nanotechnology in 2001. The history heralds a future as eventful as the past. The aspirations of the future are epitomized in the the logo adopted by the new institution. The logo is that of Hermes, the herald of the Olympian gods, embodying the institution's mission to serve as a 21st century educator, innovator, and economic catalyst. Hermes is the author of many inventions, the god of commerce and promoter of interaction among nations, and celebrated for his helpfulness to mankind. Aided by the wings on his sandals and his cap, Hermes traveled with great swiftness, an embodiment of CNSE's agility in exploring and implementing new opportunities to educate, innovate, and enable economic vitality.