



Student-led companies expand the nanotechnology innovation ecosystem

Innovation and entrepreneurship are engines of the economy. As such, they are central to the National Nanotechnology Initiative (NNI) and its mission to expedite the discovery, development, and deployment of nanoscale science to serve the public good. NNI agencies have been supporting efforts to promote innovation and train the next generation of nanotechnology entrepreneurs through programs such as the National Institute of Health's Translation of Nanotechnology in Cancer Consortium, the Air Force Office of Scientific Research-supported Nano-Bio Manufacturing Consortium, and the National Science Foundation's (NSF's) Innovation Corps.

However, fostering innovation and entrepreneurship is not just the role of the federal government. Colleges and universities, professional societies, business accelerators, public-private partnerships, and other organizations are creating opportunities for young professionals, from undergraduate students to postdocs, to

gain experience and skills in these critical areas and to prepare for successful careers. These activities go beyond formal classroom training experiences. They vary from networking events that provide opportunities for students to interact with successful entrepreneurs to competitions for student teams to win funding to start their own companies. Efforts such as these are breeding success as a number of student-led companies are springing up around the country.

Universities have always played a critical role in fostering innovation and the transfer of discoveries from the lab to market. However, many educational institutions are becoming more creative in their efforts to spur innovation and support student entrepreneurs. For example, the University Innovation Fellows Program, established under the NSF-funded National Center for Engineering Pathways to Innovation (Epicenter) at Stanford University, is fostering a nationwide network of

students that work to build an innovation and entrepreneurship ecosystem at their respective schools. Currently, there are 607 University Innovation Fellows at 143 colleges and universities across the United States. These Fellows work with the faculty and administration at their home institutions on a variety of activities, including creating innovation, collaboration, or maker spaces; forming entrepreneurship clubs; creating and modifying courses; leading workshops; and organizing competitions. This program empowers students of all disciplines to create an entrepreneurial culture.

Virginia Tech's Institute for Critical Technology and Applied Science recently sponsored a Nanotechnology Entrepreneurship Challenge for undergraduate and graduate students with the goal of taking nanoscale science and engineering discoveries from lab concept to commercial product. The first round of this challenge, held in 2014, targeted applications in public health and medicine. Winning projects included nanosensors for breast cancer cell detection, three-dimensional synthetic tissue scaffold-based tumor models to test the efficacy of cancer therapeutics, and smart salt-responsive bandages that adhere to wet skin. Winning teams received both direct funding and in-kind support, such as access to market research and meetings with professional mentors.

Startup incubators and business accelerators have been playing an important role in helping to spur innovation and support nanotechnology entrepreneurs. For example, Y Combinator, a Bay Area incubator, provides seed funding and support for early-stage startups with the goal of helping them build a compelling business case to attract larger funding from later-stage investors. Y Combinator runs two 3-month funding cycles per year. During each cycle, they encourage the founders of each startup they fund to relocate to the Bay



The AuTACA team, a startup from Wake Forest School of Medicine and winner of the NSC2 Innovation Excellence Award administered by the Center for Advancing Innovation and NIH.

Area, where they undergo intensive training and get assistance in developing their business plan. The funding cycle culminates in a Demo Day in which startups present their business plan to a group of leading investors. A recent participant in this program is Feynman Nano, a startup founded by two University of Central Florida students. Feynman Nano is commercializing a process to make nanostructured antimicrobial and self-cleaning surfaces with an eye toward reducing the number of infections in hospitals.

Public-private partnerships, such as the Nano Startup Challenge in Cancer (NSC2) and the New York Business Plan Competition, are also focusing on promoting student entrepreneurship. The New York Business Plan was founded in 2010 to stimulate and encourage innovation in colleges and universities statewide. Over the life of this competition, more than 1600 student teams from 75 institutions have made pitches for their startups. While the competition's focus is not solely on nanotechnology, it is one of the six award categories, and several of the 2016 award-winning technologies in other categories were nanotechnology-enabled. For example, Abcombi Biosciences, a company co-founded by a recent University of Buffalo biomedical engineering PhD graduate, won first place in the Biotechnology/Health Care category. Abcombi Biosciences is developing a nanotechnology-based platform for prophylactic vaccination against influenza and other pathogens. NanoHydro, led by a University at Buffalo chemical and biochemical engineering graduate student, is developing inorganic nanoparticle systems to split water and produce hydrogen for use as a fuel source in unmanned vehicles and other applications. NanoHydro won first place in the NYSERDA Energy/Sustainability category.

Professional societies, such as the Licensing Executive Society (LES), are also getting involved. The US/Canada Licensing Executive Society Foundation was established in 2000 to create a greater awareness of the role that licensing of intellectual property plays

in technology commercialization. As part of this mission, the Foundation established the International Graduate Student Business Plan Competition in 2004 to provide mentorship opportunities for student startups about business basics and best practices for intellectual property and licensing. Even though this competition is not exclusively nanotechnology focused, nanotechnology entrepreneurs finished strongly in the 2015 LES competition. Students from the University of Houston won the Grand Prize for their company, Wavve Stream, which utilizes nanotechnology to improve the efficiency and lower the cost of water filtration systems. Washington State University students won the Members' Choice Award for TriboTEX, their company that is developing an eco-friendly, nanoparticle-based lubricant that effectively reconditions moving parts during normal operation.

In support of the NNI's goal to develop the skilled workforce needed to advance nanotechnology research and development (R&D) and commercialization, the National Nanotechnology Coordination Office has been working with undergraduate students across the country to establish and grow NextTech, a nano- and emerging technologies student network. The network foundation is student-led organizations that work within their institutions and surrounding communities to promote science, technology, and innovation. Each organization sponsors a variety of activities based on the local academic culture and student interests to raise awareness of emerging technologies; promote opportunities for student research and internships; and facilitate interactions and connections between students, faculty, and industry professionals.

Representatives from these student groups met in Washington, DC, in May



Jonathan Wachob and Brandon Carpenter, students at the University of Central Florida and members of the Nano and Emerging Technologies Student Network, are co-founders of Feynman Nano. Image provided by WUCF TV.

2016 for the first Emerging Technologies Student Leaders Conference. Twenty-two students from 11 different universities attended. This conference was co-located with three long-standing conferences on nanotechnology, innovation, and commercialization: TechConnect World 2016, the National Innovation Summit and Showcase, and the National SBIR/STTR Conference. This situation provided students with a unique opportunity to not only showcase their research and hear about the latest developments in nanotechnology R&D, but also to interact with innovation leaders from academia, industry, and government and to network with entrepreneurs, government program managers, and investors.

The future demands a workforce with the technical skills to develop advanced technologies to meet the global needs and entrepreneurial skills to bring these technologies to market. Student entrepreneurs are helping to shape that future. They are clear evidence of the impact that universities, government, and the private sector can have in educating and inspiring the next generation of technology entrepreneurs. These collective efforts to foster innovation and nurture the entrepreneurial spirit of all students will benefit the future of nanotechnology.

Michael A. Meador

and **Lisa E. Friedersdorf**

National Nanotechnology Coordination Office, Arlington, Va., USA