Nanotechnology Education

-role of the schools-

Marius Enachescu, Prof. Dr.rer.nat.
POLITEHNICA Bucuresti

College, University, and
General Nanoscale Science, Technology and Engineering Programs

Currently there are **846 academic programs**, research labs, and collaborations listed.

Collaborative efforts between government, academic, and business.

academic programs

Albany NanoTech
"... a fully-integrated research, development, prototyping, pilot manufacturing and education resource managing a strategic portfolio of state-of-the-art laboratories, supercomputer and shared-user facilities and an array of research centers located at the University at Albany - SUNY."

American Sentinel University
"The nanotechnology Strategic Capstone course provides a unique opportunity for students to draw upon, demonstrate, and integrate both their professional experience and the new knowledge gained from their broader MBA coursework into a deeper understanding of the application of nanotechnology in business."

Amity Institute of Nanotechnology (AINT)
"The programme comprises of conceptual knowledge of nanoscience and nanotechnology, including preparation of nanomaterials, their characterization and applications."

Arizona State University (ASU)
Center for Nanotechnology in Society. "Designed as a boundary organization at the interface of science and society, CNS-ASU provides an operational model for a new way to organize research through improved reflexiveness and social learning which can signal emerging problems, enable anticipatory governance, and, through improved contextual awareness, guide trajectories of NSE knowledge and innovation toward socially desirable outcomes, and away from undesirable ones.", nanotechnology, microfabrication, MEMS, micro-fluidics, etc.

Boston University College of Engineering
Departmental program in Nanotechnology. "... is concerned with the mechanical and electronic properties of nanometer scale systems as well as macroscopic systems that require nanometer tolerances in fabrication, control, and measurement."

Boston University
Mohanty Group. "The central theme of our research is the exploration of quantum mechanical effects in engineered nanoscale structures and devices with a goal to study fundamental physical phenomena."

academic programs

Center for Applied Research and Technology at CMU
The Central Michigan University Research Corporation (CMURC) is a not-for-profit organization established to facilitate innovative research and development opportunities between the university and high technology companies.

Centers of Cancer Nanotechnology Excellence (CCNEs)
The Centers of Cancer Nanotechnology Excellence (CCNEs) are the core units of the science and technology programs supported by the Alliance. Each CCNE functions as a consortium or network of laboratories and research facilities organized to address one or more specific cancer nanotechnology platform needs.
- Carolina Center of Cancer Nanotechnology Excellence University of North Carolina
- Center for Cancer Nanotechnology Excellence Focused on Therapy Response Stanford University
- Center of Nanotechnology for Treatment, Understanding, and Monitoring of Cancer (NANO-TUMOR) University of California, San Diego
- Emory-Georgia Tech Nanotechnology Center for Personalized and Predictive Oncology Emory University and Georgia Institute of Technology
- MIT-Harvard Center of Cancer Nanotechnology Excellence MIT and Harvard University, Massachusetts General Hospital
- Nanomaterials for Cancer Diagnostics and Therapeutics Northwestern University
- Nanosystems Biology Cancer Center (NSBCC) California Institute of Technology
- The Siteman Center of Cancer Nanotechnology Excellence Washington University

Harvard University
Nanoscale Science and Engineering Center - Science of Nanoscale Systems and their Device Applications
The Nanoscale Science and Engineering Center (NSEC) is a collaboration among Harvard University, the Massachusetts Institute of Technology, the University of California at Santa Barbara and the Museum of Science in Boston with participation by Delft University of Technology (Netherlands), the University of Tokyo (Japan), and Brookhaven National Laboratory, Oak Ridge National Laboratory and Sandia National Laboratory.

Haverford College
"...to bring together faculty from biology, chemistry, physics, and math in the pursuit of an interdisciplinary effort to develop new protein-based biomaterials for the field of nanometer-scale electronic and mechanical device fabrication."

academic programs

Illinois Institute of Technology
Center on Nanotechnology and Society (CONAS) "... to catalyze informed, inter-disciplinary research and education on the implications of nanoscale science and technology for ethical, legal, policy, business, and wider social issues, and with a special focus on the human condition."

Joanneum Research - Institute of Nanostructured Materials and Photonics
"Our 15 research units make Joanneum Research one of the largest non-university research institutions in Austria." Affliated with international institutions such as the University of California at Berkeley and the Max Planck Institute for Polymer Research in Germany.

Johns Hopkins University
Materials Research Science and Engineering Center (MRSEC). One of 26 MRSECs funded by the National Science Foundation, is composed of scientists at JHU, Brown University, and the National Institute of Standards and Technology (NIST). Research in the Center focuses on nanostructures made from novel materials that exhibit enhanced magneto-electronic properties.

Massachusetts Institute of Technology (MIT)
BioInstrumentation Laboratory. Technologies that are currently being developed in the BI Lab include a servo-controlled laser micro-surgical robot, artificial muscle technology based upon conducting polymer biomimetic materials, the Living Chip, a cell-based high throughput screening system for mass-scale discovery of new drugs, and the Nanowalker, a nano-stepping autonomous robotic instrumentation platform.

Metroplex Research Consortium for Electronic Devices and Materials (MRCEDM) combines the research and development capabilities of The University of Texas at Arlington, Southern Methodist University, Texas Christian University and The University of North Texas to assist companies that innovate and manufacture advanced technical components and systems.

Nanobiotechnology Center (NBTC)
The Nanobiotechnology Center was established in January 2000 as a Science & Technology Center, with core funding from the National Science Foundation. Nanobiotechnology is an emerging area of scientific and technological opportunity that integrates nano/microfabrication and biosystems to the benefit of both. The Nanobiotechnology Center is characterized by its highly interdisciplinary nature and features a close collaboration between life scientists, physical scientists, and engineers. It has a fully integrated education and outreach effort in which all NBTC faculty participate. The Center brings together experts in their fields from Cornell University, the Wadsworth Center (New York State Health Department in Albany), Princeton University, Oregon Health & Science University, Clark Atlanta University, and Howard University. It also involves the active collaboration of K-12 educators, the Sciencenter Museum in Ithaca, NY, and representatives from industry and the government.

academic programs

Nanotechnology Institute (NTI)
A collaboration led by Ben Franklin Technology Partners of Southeastern Pennsylvania, Drexel University and The University of Pennsylvania. "... to focus on the transfer of discoveries and intellectual knowledge in the area of nanotechnology from universities to industry partners and on the rapid application and commercialization of this technology to stimulate economic growth."

National Center for Learning and Teaching in Nanoscale Science and Engineering (NCLT)
The mission of NCLT is to develop the next generation of leaders in NSE teaching and learning, with an emphasis on NSEE capacity building, providing a strong impact on national STEM education. The guiding theme of NCLT is learning and teaching through inquiry and design of nanoscale materials and applications.
(Science, Technology, Engineering, and Mathematics (STEM)); (Nanoscale Science and Engineering Education (NSEE))

Nanofactory "A portal to showcase and connect providers of nanoscience and micro-technology based in the Yorkshire and Humber region with other regional, national and international communities and users."

academic programs

National Nanotechnology Infrastructure Network (NNIN)
"an integrated networked partnership of user facilities, supported by the National Science Foundation, serving the needs of nanoscale science, engineering and technology."
Members of the NNIN include (and are also listed above):
•Cornell Nanoscale Facility at Cornell University
•Stanford Nanofabrication Facility at Stanford University
•Solid State Electronics Laboratory at the University of Michigan
•Microelectronics Research Center at the Georgia Institute of Technology
•Center for Nanotechnology at the University of Washington
•Penn State Nanofabrication Facility at the Pennsylvania State University
•Nanotech at the University of California at Santa Barbara
•Microtechnology Lab at the University of Minnesota
•Nanoscience at the University of New Mexico
•Microelectronics Research Center at University of Texas at Austin
•Center for Imaging and Mesoscale Structures at Harvard University
•Materials Science Research Center of Excellence at Howard University
•Triangle National Lithography Center at NCSU (DUV lithography only) (Affiliate)

Prior to March 2004, was called the National Nanofabrication Users Network (NNUN) a NSF-sponsored partnership of user facilities to provide opportunities for researchers to turn new ideas in nanoscale science and technology into experimental reality.

The University must remain
“a place of light, of liberty and of learning”

(Benjamin Disraeli, 1873)

The trouble with our times is that the future is not what it used to be.

Paul Valery

CONCLUSION : MANAGING UNCERTAINTY

In today's chaotic, complex, changing and unpredictable world, there is only one certainty: **we are facing uncertainty**.

So, the University has a critical role to play:

1. Equip our students to deal with uncertainty,
2. Through research, transform uncertainty into innovation,
3. Manage our institutions to be adaptive enough to deal with uncertainty,
4. In society, provide a forum to turn uncertainty into a brighter future for us all.

THE WAY WE SHAPE THE FUTURE OF OUR STUDENTS,
RESEARCH AND OUR UNIVERSITIES,
WILL ALSO SHAPE
THE FUTURE OF SOCIETY AND THE WORLD.

If one cannot predict the future, one must invent it.

University
and
Industry Partners

Understanding University and Industry Partners

Guiding Principles of University-Industry Partnerships

• ***Develop a shared vision and clear expectation for what the partnership will accomplish.***
Before entering a partnership, both parties should acknowledge each other's mission and the related objectives and constraints faced by both (these objectives and constraints are discussed below). Assessments of what each party can contribute, and the desired outcome of the partnership should be agreed upon.
• ***Address the image that some academics have of industry support as "tainted".*** Universities should acknowledge that some academics view funding from industry as having strings attached that negatively affect their research. Open and honest discussions held between parties can help address this issue.
• ***Establish porous boundaries between government, industry, and academia, by developing clusters and innovative regions.*** Developing innovative clusters and regions can reduce some of the hard barriers between partners. These clusters also can allow for a flow of inventions, ideas, and personnel between governmental, industrial, and academic institutions.
• ***Create a common organizational structure for research.*** One of the commonly cited barriers to partnerships between universities and industry is the misalignment of organizational structures. For collaborative research projects, a common organizational structure should be developed and agreed upon prior to beginning the project.
• ***Develop a strategic, long-term commitment.*** Long-term commitments are believed to deliver results that have more impact than isolated collaborative projects, and can provide a broader range of benefits to all parties involved.
• ***Enlist support from leadership and scientists.*** To fully develop successful relationships, support is required from both the researchers that will collaborate on projects and the leadership of each organization. Having a clear vision from leadership and engaging the scientists in developing and maintaining the partnership is vital for success.
• ***Focus on speed and nimbleness.*** Universities and industries typically have different time horizons regarding administrative requirements. While spending six months on reaching an agreement may be acceptable to academic partners, industry partners may be discouraged to continue as their research projects have specific timelines. Focusing on speed and nimbleness demonstrates a commitment to work with partners with more demanding time constraints, and allows for more time spent on research activities.
• ***Pre-negotiate IP and publication policies.*** Negotiations over IP are becoming more contentious and taking too much time. Of all respondents to a survey conducted by the Industrial Research Institute, 100 percent agreed that IP issues are an impediment to working with U.S. universities. Being a complex issue, there are a broad range of views on this issue and each partnership should develop its own arrangement based on the context of the collaboration. However, policies involving IP rights, publication of research results, funding of graduate students and post-doctoral fellows, and other issues should be negotiated in advance to resolve issues before they arise.

Objectives, Contributions, and Constraints of Universities and the Private Sector

Public-private collaborations on R&D may take place for many reasons.
Here is summarized the ways that universities and industry can contribute to each other's missions, and the unique constraints that each faces.
Although university-industry collaborations are just one way in which public and private actors can partner, the table exhibits the opportunities and barriers that may exist in many different cross-sectoral partnerships

	University	**Industry**
Objectives	• To benefit the public by adding to and sharing knowledge broadly • Educate and support an educated and welltrained workforce • Transfer technology and knowledge to enhance commercialization • Foster economic development at State and national levels	• Create and deliver new and improved products and services to enhanceprofitability • Locate advancements made by others that solve/answer general and specific problems faced by the industry partner • Develop and support an educated, welltrained, and competitive workforce

Objectives, Contributions, and Constraints of Universities and the Private Sector

	University	Industry
Constraints	• Must educate students • Must perform research for public benefit • Must operate within changing Federal and State rules and regulations, e.g. non-profit tax rules, export regulations and increased regulations on the use of humans, animals and hazardous materials • Must manage potential and actual conflicts of interest and commitments • Must be consistent with all sponsors • Academic year limitations on student and faculty time • Facing Federal funding that is limited or nonexistent • Lack of match between industry segmentation of research and university segmentation (shared constraint)	• Research investments must show returns • Can distinguish basic and applied research, but distinction not always recognized by universities • Differences between external and internal research must be recognized and planned for by industry • External research must be part of a competitive business plan and budget • Must establish agreements in a commercially timely manner • Must establish agreements to ensure the ability to commercialize with appropriate returns • Research funded by industry usually requires clear goals, milestones, and specific time frames for completion

Objectives, Contributions, and Constraints of Universities and the Private Sector

	University	Industry
Contributions to the other partner's missions	• Training of future and current industry workforce (students) through undergraduate and advanced degrees (retention of trained work force) • Contribution to the general knowledge base for public benefit (publication) • Advancing the state of the art in a field • Acting as a filter to distill, from the general public knowledge base, a subset of that knowledge particularly applicable to industry's product needs (knowledge transfer) • Performance of specific research on behalf of industry (sponsored research) • Licensing inventions and developments (IP) for commercial purposes, including revenue generation (technology transfer) • Providing access to university-owned equipment, materials, facilities and specialized resources • Fostering economic development that expands markets • Objectively testing, evaluating and reporting on new technology.	• Employing students and graduates • Donating (equipment and money – either unrestricted or earmarked e.g., for scholarships, research, or facilities) • Providing either materials or funding for student internships and faculty sabbaticals • Employee time and knowledge donation through involvement in activities such as assisting student projects, guest lectures, service on thesis committees, service on advisory boards. • Enabling access to industry-owned equipment, materials, facilities and specialized resources • Providing leading-edge research directions • Providing financial and/or in-kind support for specific research activities of interest to the industry partner (sponsored research) • Paying technology licensing fees and royalties, which support ongoing research and educational programs • Contributing to general knowledge base (publication) • Bringing university contributions to the public in the form of goods and services (technology transfer)