Undergraduate Nanoscience and Nanotechnology Programs at University of Wisconsin-Stout

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ABSTRACT

In the Fall of 2007, the University of Wisconsin-Stout launched undergraduate programs in Nanoscience and Nanotechnology. These programs are concentration choices in he Applied Science major and Engineering Technology majors, respectively. Faculty from several departments and colleges collaboratively formulated a university wide response to nanotechnology education. Four new NANO courses have been developed to compliment the existing science and engineering curriculum. Partnerships have also been established with other institutions in Wisconsin to leverage expertise and resources. Nanotechnology is one of the core curriculum advances that is shaping UW-Stout as Wisconsin's Polytechnic University.

Keywords: nanotechnology, nanoscience, education, undergraduate, major

1 INTRODUCTION

Nanotechnology education is a natural fit for the mission of the University of Wisconsin-Stout which is a comprehensive, career-focused polytechnic university where students, faculty and staff use applied learning, scientific theory and research to solve real-world problems, grow the state's economy and serve society. Nanotechnology represents the interdisciplinary efforts of traditional areas of science, mathematics and engineering and society is experiencing many changes because of nanotechnology and is expressing a need for appropriately educated and trained graduates. The IQ Corridor, stretching from Minneapolis to Chicago, is recognized as one of the strongest regions in the nation for nanotechnology research and development. It is anticipated that many of the current businesses in this region will begin to embrace the new developments and that many new businesses will be created. One of the greatest impacts nanotechnology will have is on the diagnosis and treatment of health related conditions. The "medical device alley" located in the Minneapolis metro-area presently contains more than 200 medical device companies. As these and new companies embrace nanotechnology, a large demand will most likely be created for graduates with a strong background in nanotechnology. UW-Stout began in 2003 to develop an educational response to nanotechnology at the undergraduate level. This was a faculty led initiative that included faculty from the sciences, mathematics, and engineering. Institutional support was provided to enable strategic planning and curriculum development. A Nano Think Tank was created on campus that developed a vision for nanotechnology at UW-Stout. This Think Tank was followed by teams that developed curriculum, acquired equipment and instrumentation, and established partnerships with other institutions.

2 NANO THINK TANK

During the summer of 2004 a Nano Think Tank was formed on the UW-Stout campus. This committee was funded by the College of Arts and Sciences and College of Technology Engineering and Management. The committee consisted of six faculty members from these colleges, a science fiction write, and a public-policy maker from the region. This committee produced a report that included four recommendations to the University to assist in a decision making process for the University's response to the growth of the emerging field of Nanotechnology. These recommendations were: Infusion into Curriculum, Program (major) Development, University Restructuring, and Emerging Technologies Center. These recommendations from this Think Tank have proven to be quite influential as the University has or is currently embracing all of these recommendations. The recommendation to develop a Nanotechnology program was based on an analysis of science and economic trends related to nanotechnology. Quite simply, nanotechnology is projected to become a $2 trillion dollar industry in the next 10 years with a need of at least 2 million new jobs. The Nano Think Tank grew into a Nanotechnology Steering Committee for the 2004-2005 academic year. Membership on this committee was expanded to include membership from all of the colleges at UW-Stout. This committee established a plan to introduce a concentration in Nanoscience that could be embraced by multiple programs on campus. The first two programs to implement the Nanoscience concentration was the Applied Science and Engineering Technology programs in the Fall of 2007. The Nanotechnology Steering Committee was also successful in establishing a partnership with Chippewa Valley Technical College (2-year technical college) and University of Wisconsin-Eau Claire to enable Western Wisconsin to embrace nanotechnology on a much larger

scale. One aspect of this partnership as produced an articulation agreement with CVTC to enable students graduating from CVTC in Nanotechnology to transfer seamlessly to UW-Stout.

3 PROGRAM DEVELOPMENT

During the Summer of 2005, three faculty from Engineering, Chemistry, and Biology developed curriculum details for a undergraduate program in Nanotechnology. Science fundamentals, applications, characterization, and fabrication were four areas of nanotechnology that were identified as key educational themes. These themes were shaped by the following important nanotechnology topics identified by the committee: quantum chemistry/physics , solid state physics/chemistry, nano-structures, chemical bonding, nanofabrication, health effects, microscopy techniques, electronics-electrochemistry, molecular biology, spectroscopy, new properties of materials, and polymers. Once these key topic areas were developed, the committee worked closely with the Program Directors and their Advisory Committees in The Applied Science and Engineering Technology programs to development 4-year undergraduate concentrations in Nanoscience and Nanotechnology. These programs blend traditional courses with four newly developed NANO courses. Infusion of nano-principles is also occurring in many of the traditional courses. Listed below is the science curriculum for these new programs. At UW-Stout, all students must enroll in a general education core that encompasses about 40 credits. Each of the program requires a Co-Op or Field experience that emphasizes nano-fabrication. These programs will also become associated with a very active Stout Technology Transfer Institute in which students, faculty and businesses partner to solve real-world problems.

Curriculum for degree in Applied Science with Concentration in Nanoscience:

NANO-101 Exploration of Nanotechnology
BIO-370 Biotechnology
CHEM-201 Organic Chemistry
CHEM-301 Physical Chemistry
CHEM-303 Physical Chemistry Laboratory
CHEM-341 Chemistry of Materials I
NANO-301 Nanostructures
NANO-330 Characterization Methods of Nanomaterials
NANO-401 Applications of Nanotechnology
Co-Op or Field Experience (Nano-fabrication)

Choose 9-10 credits from the following courses:
CHEM 311 Biochemistry
CHEM-325 Chemistry of Polymers
MFGE-343 Metal Casting, and Ceramic and Powder Metal Processes
CHEM-470 Chemistry of Materials II
ELEC-290 Circuits and Devices
MFGE-333 Polymer Processes
CHEM-440 Advanced Materials Laboratory
CHEM 204 Organic Chemistry II

Take all:
ENGL-415 Technical Writing
BIO-135 Organismal Biology
BIO-136 College Molecular Cell Biology I
CHEM-136 College Chemistry II
CHEM-335 Instrumental Methods of Analysis
CHEM-331 Quantitaive Analysis
PHYS-281 University Physics I
PHYS-282 University Physics II
STAT-330 Probability and Statistics for Engineering and the Sciences
APSC-311 Issues for Scientific Professionals
APSC-201 Applied Science Profession I
APSC-401 Applied Science Profession II

Curriculum for degree in Engineering Technology with Concentration in Nanotechnology:

RD- 100 Introduction to Engineering Technology
RC- 381 Occupational Safety/Loss Control
INMGT- 200 Production Operations Mgmt
INMGT- 400 Organizational Leadership
BUACT- 200 Financial-Managerial Accounting
BUMKG-330 Principles of Marketing
ENGL- 415 Technical Writing
MFGT- 150 Introduction to Engineering Materials
RD- 205 Design for Industry
CADD- 112 Principles of Engineering Drawing I
MFGT- 251 Polymer & Composite Processes

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MFGT- 252 Material Removal and Forming Processes
MFGT- 253 Joining and Casting Processes
ELEC- 204 Electricity Fundamentals
POWER- 260 Intro to Fluid Power
NANO-101 Exploration of Nanotechnology
NANO-301 Nanostructures
NANO-330 Characterization Methods of Nanotechnology
NANO-401 Applications of Nanotechnology
NANO-xxx Nano-fabrication coop/field experience
ELEC 260 Electrical Circuits
ELEC 271 Digital Logic and Switching
ELEC 341 Elec & Mech Interface Devices
MECH - 290 Mechanics of Solids I

Choose 9 credits:
MECH 291 Mechanics of Solids II
ELECT 272 Solid State Electronics
ELECT 274 Microprocessors
MFGT 340 Plastics Processing
INMGT 300 Engineering Economy
INMGT 314 Industrial Enterprise Practicum
INMGT 320 Quality Tools
CHEM 136 College Chemistry II
CHEM 325 Chemistry of Polymers
SPCOM- xxx Advanced Speech

These programs have been implemented for the Fall of 2007, but strong interest has been shown by current students.

4 NANO COURSE DEVELOPMENT

Development of four new NANO courses required the curriculum team of faculty to closely analyze the current curriculum and course content in the Applied Science and Engineering Technology programs. Each of the programs offer a strong science and engineering background. The unique Nano curriculum was organized to be delivered through the following four courses. The NANO 101 course will also be a General Education course. Several programs from across campus expressed an interest for their student to gain at least a fundamental background in nanotechnology. The NANO 330 course will be a lab intensive course examining electron and scanning probe microscopy techniques. The NANO 301 and NANO 401 course will be non-lab courses designed to be offered online. It is envisioned that these courses may have a broad interest by students in a variety of science and engineering programs or even science professionals in need of an in depth course in nanostructures and applications.

NANO 101 Exploration of Nanotechnology
Introduction to main principles and concepts of nanotechnology with an exploration of the societal and environmental impact of nanotechnology across a vast array of fields including health care, manufacturing, environment, biotechnology, energy and food production, and information technology.

NANO 301 Nanostructures
Introduction to nanostructured materials, theory of processes to design materials with nanostructure, and properties and behavior of nanostructured materials.

NANO 330 Characterization Methods of Nanomaterials
Laboratory based course that covers basic techniques and theory of modern characterization methods of nanomaterials. Techniques include: electron microscopy, scanning probe microscopy, diffraction spectroscopy, and emission spectroscopy.

NANO 401 Nanotechnology Applications
Review of current nanotechnology applications including societal effects.

These courses will not be "housed" in any specific department or college at UW-Stout. Early plans include these courses to be taught by faculty from the Chemistry, Biology, and/or Engineering Departments. Institutional and extramural funds have been used to purchase a variety of equipment and instrumentation to support these course.

5 FUTURE DIRECTIONS

The nanotechnology educational effort at UW-Stout at the undergraduate level has been quite impressive and timely. Quite often, university response time for curriculum development lags the needs of business and industry. The polytechnic focus of UW-Stout has enabled the university to work closely with outside stakeholders to be proactive for curriculum development across the campus. The university has also begun examining its organizational structure to better enable the university to foresee and respond to the scientific and technological needs of society in the 21st century.