Skill Set for the Nanotechnology Workforce Defined by NSF NACK Center at Penn State

The Center for National Nanotechnology Applications and Career Knowledge (NACK) at Penn State has developed an associate degree level skill set that qualifies a worker as a Nano-Technician for a broadly-trained nanotechnology workforce.

The skill set was established by the National Center for Nanotechnology Applications and Career Knowledge (NACK) at Penn State based on intensive interviews and surveys involving more than 200 companies over nearly ten years spanning virtually all industries using nanotechnology across the nation. A technician possessing these skills will have completed a broad, hands-on educational experience in micro- and nanofabrication, and is fully prepared to actively contribute to any industry using micro- or nanotechnology, including the electronics, biotechnology, pharmaceuticals, energy, materials manufacturing, and chemical industries.

The skill set encompasses: 1) safety, and environmental protection awareness; 2) foundation skills such as equipment use and maintenance as well process design and control; 3) foundation skills in pattern transfer including block co-polymer techniques and optical, e-beam, and ion beam lithography; 4) fabrication skills including both bottom up (e.g., self-assembly, catalyzed nano-wire growth, colloidal chemistry) and top-down (e.g., etching, deposition, materials modification) processing; 5) characterization skills (e.g., optical, scanning probe, and electron microscopy); and 6) professional skills (problem solving, project management, team building, research methods, IP awareness, report writing, and presentation skills).

The NACK Center is now working in partnership with the National Council for Advanced Manufacturing (NACFAM) to obtain recognition, adoption and endorsement of the Nano-Technician skill set as a national standard by certifying organizations such as the Manufacturing Skill Standards Council (MSSC) and the American National Standards Institute (ANSI). In parallel, the NACK Center is working toward accreditation of associate degree education programs addressing the Nano-Techician skill set through the Accreditation Board for Engineering Technology (ABET). The aim of these activities is to ensure consistently high quality in US micro- and nanofabrication associate degree level technician education.

The NACK Center is a NSF Advanced Technological Education (ATE) national center, created in October 2008 to assist community and technical colleges across the United States develop micro- and nanofabrication education and workforce development programs. The NACK Center builds upon the NSF ATE Regional Center for Nanofabrication Manufacturing Education (CNME) which operated at Penn State from 2001 to 2008. Nanotechnology education and workforce development efforts at Penn State have been supported continuously by the Pennsylvania Department of Community and Economic Development since 1998.

The NACK philosophy is to provide a nanotechnology education that will enable graduates to be marketable for their working-lifetime in today's fast moving world. A capstone course suite in nanotechnology developed by NACK, working with a broad spectrum of industry, is designed to have students emerge with the NACK-industry co-developed exit skill set. Students emerge from this suite of courses having had a hands-on exposure to the incredible capabilities now available for 'seeing' and characterizing the nano-world. These include techniques such as field emission microscopy and scanning probe tools. Students also must know about, understand, and be able to apply pattern transfer concepts and tools, as well as have the same facility with the broad spectrum of fabrication/synthesis

techniques used in advanced manufacturing from reactive ion etching to atomic layer deposition and molecular self-assembly.

NACK is engaged nationally in bringing this nanotechnology workforce development effort to every corner of the US by promoting resource-sharing partnerships between Penn State and other research intensive universities, which have the expertise and facilities to support meaningful, hands-on nanotechnology workforce education, and community and technical colleges which need access to these resources. In the NACK approach, these resources are shared by some combination of (1) 2-year and 4-year institutions sending students to the research university for immersion into the capstone course suite, (2) institutions using web-access to courses or selected modules offered by the research university, and (3) web-access to laboratory equipment operation.

The NACK resource-sharing approach was developed under funding from Pennsylvania's Department of Community and Economic Development and the NSF, and has now evolved into the national NACK Center, inaugurated in the fall of 2008. In Pennsylvania, over 500 hundred students from partner community and technical colleges and other institutions have completed the capstone course suite utilizing this resource-sharing approach. Virtually all have found nanotechnology jobs in more than 90 firms ranging from pharmaceutical to photovoltaics companies.

The NACK resource-sharing approach is designed to provide the means by which two-year degree and other institutions can have the resources, expertise, and facilities to deliver the broad micro- and nanotechnology education required to empower the US and its technician workforce and to give both the resiliency needed for today's world. More information on the NSF National Nanotechnology Applications and Career Knowledge Center can be found at www.nano4me.org.