TRANSFORMING U.S. WORKFORCE DEVELOPMENT POLICIES FOR THE 21st CENTURY

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Part 2

Redesigning Workforce Development Strategies
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Workforce Development
in a Targeted, Multisector
Economic Strategy
The Case of State University of New York’s
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Cutting-edge strategies for regional economic development aim to harness and leverage the expertise and resources of universities, industry, and government to generate economic growth. Such strategies often follow the Triple Helix innovation model, building out innovation infrastructure to stimulate regional economic activity (Etzkowitz and Leydesdorff 1997). Economic growth emerges, in part, from a workforce with the skills needed to take up jobs within the R&D clusters and to attract new firms in associated sectors to the region (Schultz 2012; see also Bartik 2009 and Moretti 2012). This case study describes how the State University of New York’s (SUNY) Colleges of Nanoscale Science and
Engineering (CNSE)—a state-supported, high tech/higher education, public-private partnership geared toward economic development—has led to transformation in the Capital Region’s workforce. More specifically, the case demonstrates CNSE’s roles in fostering the development of the nanotechnology workforce at different levels and types of education skills, in response to information about local employer demand. Initial results indicate the potential of CNSE’s approach to workforce development to address growing and evolving nano-related skill and workforce needs in the region and beyond, though further research is required.

CNSE AND ECONOMIC DEVELOPMENT

Established in 2001, CNSE emerged as a key component of state policy development geared to reversing a long-term decline in New York’s upstate economy, particularly the loss of high-tech manufacturing, which had fallen to less than 4 percent of New York State’s economic output. At CNSE’s founding, New York State and IBM jointly invested $150 million for the creation of a research center dedicated to nanoelectronics and nanotechnology, with CNSE also offering graduate degrees in nanoscale science and engineering. CNSE was selected to host the center based on its already extensive research portfolio in semiconductor fabrication and existing relationships with industrial partners such as IBM, SEMATECH, Texas Instruments, and General Electric (Schultz 2011). Following the Triple Helix framework, CNSE manifests a unique university-industry-government collaborative research center with a core mission of nanotechnology research and development, deployment, and economic development.

Since 2001, Tokyo Electron, Applied Materials, SEMATECH, and 300 other collaborators have joined IBM in colocating research operations at CNSE to take advantage of state of the art infrastructure for the development of next-generation technologies. To date, CNSE has attracted $20 billion in private and public investment in the physical infrastructure needed for the research, development, and manufacturing scale-up of advanced nanotechnologies in areas such as semiconductors, electronics, energy, and pharmaceuticals (Schultz 2011). Nanotechnol-
ogy R&D carried out at CNSE has complemented substantial public and private investment in nanotechnology-related manufacturing in the Capital Region. In 2012, GlobalFoundries commenced production at its new $4.6 billion chip manufacturing facility, Fab8 (with $1.2 billion in New York State subsidies), in Malta, New York, which employs more than 2,200 workers. A $10 billion expansion is expected to increase employment to 3,200 (Rulison 2014). Other companies now located in the Capital Region include equipment manufacturers Vistec and cleanroom construction contractors M+W Group. In 2014, the SUNY Board of Trustees approved the merger of CNSE and the SUNY Institute of Technology (Utica, New York). The merged institution is named SUNY Polytechnic Institute.

**CNSE AND WORKFORCE DEVELOPMENT IN NEW YORK’S CAPITAL REGION**

There is limited but growing information on labor market demand and needs for the Capital Region’s nanotechnology economy. A particular difficulty with extant employment data from routine collections carried out by the U.S. Department of Labor is that existing classification schemes do not enable a good delineation of enterprises and employment in the nanotechnology economy. Specialized studies undertaken for nanotechnology-related industry nationally suggest that a wide range of education levels and skills is needed (Roco 2011; Yawson 2010). For the Capital Region, CNSE conducts its own quarterly census of nanotechnology employment. With the help of industrial partners, CNSE assembles information on the number of employees in nano-related manufacturing, by job description. As of 2013, CNSE and regional industrial partners accounted for over 7,000 employees in the Capital Region’s nanotechnology economy.

Evidence on skills gaps and likely needs with respect to the regional nanotechnology economy is limited. The Siena Research Institute’s (2014) annual survey of upstate business leaders elicits broad projections of hiring and broad assessments of the quality of the local workforce. These projections and assessments lack the detail necessary to guide the development and/or expansion of degree or training pro-
grams geared to nano-related industry. As employment in the sector has ramped up, the largest nanotechnology-based employer (Global Foundries) reported that the Capital Region’s workforce supplied about half of those needed to fill its own job openings (Hagerty 2013). Many employers confront similar conditions, as reported in a Siena Research Institute survey, from a tabulation of responses to the question, “... is there an ample supply of local workers that are appropriately trained for your employment needs?” About half of upstate business leaders responded “yes,” with somewhat lower shares for business leaders in the Albany region or for all upstate manufacturing. According to Global Foundries, the greatest difficulties appeared in recruitment of those with two-year degrees and specialized training in applied science, technology, engineering, and math (STEM) fields (Hagerty 2013). A 2008 report assessing upstate New York’s potential for attracting nanoscale manufacturing, however, found that CNSE is a good source for well-trained engineering graduates (Semico Research Corporation 2008).

CNSE obtains information on likely employment needs, by education level and skill, partly through discussions with ongoing and new industrial partners. Within structured partnerships designed specifically to provide education and training, employers provide some indication of hiring needs. That input helps shape the size and design of the training provided. One very distinct example is the Center for Construction Trades Training, a partnership between primarily CNSE and M+W Group that provides specialized apprenticeship for union members needing to meet special demands of nanoscale construction. The partnership developed on the basis of skill needs of the industrial partner; it relies on CNSE for development and delivery of the curriculum and access to CNSE’s industrial scale facilities for real-world experience.

CNSE also obtains information on likely employment needs from firms anticipating hiring. These firms seek the assistance of CNSE in recruitment of qualified workers in the near term through job fairs. From 2006 to 2013, CNSE-hosted job fairs have accounted for more than 1,500 job postings, covering the full span of education and training requirements as identified by the participating industrial partners. The volume and profile of posted job openings provide real-time measures of additional demand from employers. In addition, information on nano-related employment demand is found in publicly available agreements established between New York State and firms receiving
Workforce Development in a Targeted Economic Strategy

incentives to relocate in the Capital Region. These firms are obliged to report the number of jobs created and retained.

Table 15.1 contains brief descriptions of new, expanded, or modified workforce development programs yielding the qualifications and skills needed for nano-related jobs. As shown there, workforce development for the Capital Region’s nano-related economic development aligns with the profile of the skill demands noted above. An important finding of this study is that CNSE is engaged at all levels and in all types of workforce development, not just its own academic degrees in nanoscale science and engineering. In what follows, we elaborate on the brief descriptions to convey more fully the levels and types of education and training provided, how information on workforce needs shaped the provision, CNSE’s role, and specific program outcomes insofar as they can be gauged.

Graduate and Undergraduate Degrees

CNSE’s most direct role in workforce development is through the supply of graduates in nanoscale science and engineering at the bachelor’s, master’s, and PhD levels. The degree programs strongly complement CNSE’s research and development work, as the most advanced students participate in that work and some graduates remain as post-docs. More broadly, expansion of the master’s and bachelor’s degree programs has followed growth in nanotechnology-related industry and associated employment demands. The college graduated its first PhD and master’s degrees in 2004 and its first bachelor’s degrees in 2013. Curricula are cross-disciplinary, with concentrations in materials engineering, nanobiology, nanoelectronics engineering, energy applications, and economic impacts. Graduates in nanobiology, for example, will have learned the physical, chemical, and engineering principles underlying the methods they are using.

CNSE’s own data on graduates show that one-third have accepted positions in the nanotechnology economy in the Capital Region. At the graduate level, a little more than half (54 percent) take up jobs in New York State, almost all in nano-related industry. These data come from a regularly updated database of graduates, containing information on employment status, location of job, and salary. On selected metrics, CNSE’s graduates are more likely to be employed in-field and in-state
<table>
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<th>Level and type of skill development</th>
<th>CNSE as provider.</th>
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<td>Bachelor’s degrees in nanoscale science and engineering. Graduates: 49 since 2013; 16 in 2014.</td>
<td>Nanotechnology-related associate’s degrees and certificates offered at six regional community and technical colleges. Coordinated through the Northeast Advanced Technological Education Center (NEATEC), a training and information center built on a community college/higher education/industry partnership. Funding: $3 million from the National Science Foundation to establish NEATEC. Graduates (Four New York community college sites only): 156 since 2008, 36 in 2013.</td>
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<tr>
<td>Master’s and PhDs in nanoscale science and engineering. Graduates: 159 since 2004; 18 in 2014.</td>
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<td>Internships</td>
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<td>Internship for community college students, consisting of 20 weeks at CNSE and GlobalFoundries.</td>
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<td>Center for Construction Trades Training, with M+W Group, offering training in nano-related construction. Funding: $3.5 million, from state of New York, M+W Group, CNSE, and Arsenal Business and Technology Partnership. Completers: estimated 200 per year.</td>
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<td>CNSE technicians.</td>
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<td>Tech Valley High School, regional “school of choice,” under governance of Capital Region and Questar III BOCES.</td>
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<td>Curriculum</td>
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<td>Graduates: 85 since 2011; 29 in 2013.</td>
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<td>NanoHigh, with Albany City School District.</td>
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<td>Completers: 125 since 2007; 13 in 2014.</td>
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<td>Early College in High School, Ballston Spa Central School District, and Hudson Valley Community College.</td>
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<td>Funding: estimated $350,000 to date from New York State and agencies, plus additional public funds through regional BOCES.</td>
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<td>Completers: 65 since 2013, 43 in 2014 (next year from 17 area school districts).</td>
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<td>Field trips to CNSE and teacher development activities to enrich science, technology, and math classes.</td>
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SOURCE: Information assembled from program materials, agency reports, newsletters, press releases, and interviews.
than is the case nationally or for other SUNY programs. With respect to field of employment, the most recent national survey of doctorate recipients showed that 11 percent of science and 40 percent of engineering doctorates accepted positions in industry—both lower than the CNSE experience. With respect to employment, unpublished results from an analysis of matched wage records for all SUNY graduates show that slightly less than half of all graduates with postbachelor’s engineering degrees were employed in New York State. The latter figure is not comparable to the CNSE estimate. The SUNY-matched wage record data pick up employment two quarters after graduation, while CNSE’s data are updated as faculty and staff learn about graduate employment. Moreover, the SUNY-matched record data include any employment for which a wage record is generated (and so would include, for example, doctoral graduates on postdoctoral appointments at CNSE or elsewhere in New York State). On this SUNY-matched record metric, the comparable in-state employment rate for CNSE master’s and doctoral graduates is about two-thirds.

Community Colleges

In 2005, Hudson Valley Community College, in partnership with CNSE and with input from local firms, established a new specialized semiconductor manufacturing technology associate degree program aimed at preparing graduates for jobs as clean-room technicians or workstation operators in the region’s nano-related economy. By 2010, CNSE’s engagement in such programs extended to six area community and technical colleges (four in New York, one in Vermont, and one in Massachusetts). The National Science Foundation–funded Northeast Advanced Technology Education Center provides the formal framework for the community colleges to engage with CNSE, other universities, and local employers to identify workforce training needs and develop and offer nanomanufacturing modules and specialized degrees. CNSE participates in curriculum development and offers hands-on instruction in its clean-room labs. Recently, CNSE and GlobalFoundries partnered with the programs to offer capstone internships that provide real-world experiences as students approach graduation.

The degree programs are relatively new, with limited information on the numbers of students enrolled, eventual graduates, and of grad-
uates, those employed. With reference to unpublished analyses from matched wage records for all SUNY graduates, an estimated 53 percent of all SUNY associate’s degree recipients in engineering fields were employed in New York State in the second quarter after graduation. The comparable figure for the community colleges in New York providing specialized technology degrees in partnership with CNSE was slightly higher, at 54 percent. However, the latter calculations include all associate’s degrees in engineering, and so do not provide a good measure of in-state employment rates for graduates from the specialized technology degree programs alone.

**On-the-Job and Advanced Vocational Training**

Targeted nano-related workforce training needs are identified and programs developed in response to employer demand. At both the Center for Construction Trades Training, a partnership between CNSE and M+W Group to provide apprenticeship training related to nanoscale construction, and GlobalFoundries, which provides on-the-job training for workstation operators, employer-identified skill needs drive provision. CNSE’s role resides in the development and delivery of the curriculum.

**K–12 Education**

Workforce development associated with the region’s nano-related economic development extends to the high school level. The learning opportunities include innovative nano-related science and technology coursework offered at Tech Valley High School, a regional “school of choice” relocating to CNSE, Albany High School’s NanoHigh, and Ballston Spa’s Early College High School, among others. Initiated by the school districts or regional Boards of Cooperative Education Services (BOCES) with state funding as additional incentive, these programs are shaped in part through engagement with CNSE. Teachers participate in CNSE workshops and receive curriculum materials from CNSE. Students learn in class sessions led by CNSE staff or on field trips to the clean-room labs at CNSE.

While similar if less intensive support for teaching and learning is made available by CNSE to schools and teachers throughout the Capital
Region, the more structured programs identified here purposefully lead students to advanced studies and eventual jobs in the field. In Ballston Spa’s Early College High School program, students dual-enroll at Hudson Valley Community College, attend project-based classes at Hudson Valley’s site in Malta, New York (some classes delivered by community college faculty), in the mornings, and on completion earn up to 20 credits toward a specialized nano-related associate’s degree at the community college.

Information supplied by school officials shows that more than half of graduates of Tech Valley High School and a similar share of completers of Ballston Spa’s Early College High School program appear to continue studies in science, technology, engineering, and math fields, including nano specializations. This rate of continuation into these fields is about four times the rate for all college-going high school graduates. The comparison, however, does not take account of differences in interests or other characteristics between students in the structured programs and those following regular high school course work. Yet, according to information supplied by school officials, the innovative technology-based programs just described enroll a good mix of students, from both urban and rural schools and from a range of socioeconomic backgrounds (as many as one-third are on free or reduced lunch and almost 20 percent have special needs).

CONCLUSION

CNSE’s engagement in workforce development follows the model of university-industry-government partnership adopted in the Capital Region’s nanotechnology-government partnership adopted in the Capital Region’s nanotechnology economic development strategy. As shown in Table 15.1, the school serves as a partner in most of the examples of education and training. In this way, it contributes to a much larger volume of nano-related workforce development than the number of its own degrees would suggest. Partnerships for CNSE take the form of collaboration with industry in identification of employment needs and the development of curricula, with other educational providers for delivery of instruction at all levels, and with local, state, and federal governments as well as industry partners for funding.
As the brief descriptions suggest, CNSE’s engagement in workforce development varies by level and type and training. The school is fully responsible for the design and delivery of its own degree programs and internships and training for those working in clean labs on-site. For community college partnerships, CNSE works with industrial partners as well as other universities and the community colleges to discern the employment needs, design the curricula, and deliver the instruction. For specialized training partnerships, it assumes responsibility for the development and delivery of the training, but it relies on industrial partners for information on skill needs and program volume as well as financial support. For the high school partnerships, CNSE’s role is largely in the domain of curriculum development and delivery. The school provides consistency across these levels and types of education and training insofar as it ensures coverage and depth of nanotechnology content and associated skill development. This consistency is achieved through CNSE’s participation in curriculum development, instruction, and hands-on learning experiences. Yet, CNSE assumes no responsibility for the overall coordination of provision of the workforce development programs. It relies on partnership, and particularly on employer demand in terms of recruitment needs and skills requirement as manifested to CNSE or within existing partnerships, to initiate development of the programs.

Evidence on the effectiveness of such an approach remains limited, if suggestive. Job postings, employer requests for training, and employer expectations of likely employment needs are anchored on the demand side, and thus are more closely tied to near-term economic activity. Data on employment outcomes of the programs remain incomplete and dispersed. Information needed to assess the supply response to evolving employment needs is not (yet) available. The development of such information represents a useful target for further work.

Notwithstanding the limitations, such evidence as exists raises the possibility that workforce development programs organized through partnerships may facilitate a dynamic response to changing employment needs in the nano-economy, allowing for expansion of provision where demand for skills warrant it and for elimination of provision when demand or requisite program requirements are not met. Moreover, for CNSE, engagement through partnerships makes sense when the levels and types of education and skills being developed extend beyond its
own specialized bachelor’s and advanced degrees in nanoscale science and engineering. Through CNSE and with financial incentives and other considerations, New York State now seeks to replicate the collaborative university-industry-government model for economic development in other upstate regions.

References


