Education and Workforce Development

Recommendations

There are several key recommendations that the General Assembly should pursue in the 2007 session in the area of education and workforce development in order to support the long term health of the nanotechnology industry in Virginia. These are:

1) Fund House Bill XXX, which provides for grants for students who are pursuing engineering degrees at Virginia universities and who work in Virginia high technology companies upon graduation.
2) Complete HJR25, the study of how to systematically enhance STEM education in Virginia with a set of comprehensive actions that reach into the curriculum that is delivered every day into the classroom. Provide for the continued creation and education of enough Science, Math and Technology teachers to support the actions and ensure that the actions align with the actions being implemented at a National level in support of the study, Rising Above the Gathering Storm. The actions need to include the immediate education of the leadership of the public school system as well as an advertising campaign that educates the citizens across the Commonwealth.
3) Convene a workshop with participation from the key stakeholders from universities, industry and the school system, who are interested and actively pursuing K-12 outreach activities in order to identify best known methods, pursue collaborative activities, and define a set of actions which can impact the overall Commonwealth.
4) Fund the creation of educational programs to provide for the following: 1) a comprehensive Manufacturing Technician certificate from the VCCS, and 2) true asynchronous engineering degree programs for undergraduate and graduate degrees to support the continuing education needs of people employed in the high technology industry who work shift schedules and need non-traditional education programs. The initial degree programs should be oriented towards those degrees which support the further development of skills in nanotechnology, such as electrical, chemical and mechanical engineering and materials science.

In considering the major innovations in the last 60 years one quickly concludes that the vast majority are the result of engineering and technology. Some examples are the transistor, integrated circuits, the microprocessor, the internet, cellular telephony, robotically assisted surgery, gene splicing, tissue engineering and CAT scans. One can view lists of some of these major innovations at the following web sites: www.research.ibm.com/about/top_innovations_history.shtml, www.fashion-era.com/20th_century_major_innovations.html, and www.mhtx.com/technology/micro_fuel_cell/marketanal_e.html

Innovations are the driving force behind our economy and in order to drive future innovations the United States needs around 100,000 new engineers each year but only

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produces around 57,000 and imports the remainder. Are these figures sustainable? No, for two reasons; (1) since 9/11 we have tightened our visa process, and, even more worrisome, (2) we are no longer the only location of choice for bright young minds, but are in severe competition with Asian countries such as India and China.

We must maintain and enhance the number of domestically produced engineers each year in order to maintain our position of prominence in technological innovation and thus our robust economy. This means we must implement strong measures to interest students from elementary level through high school in science and engineering and bolster the output of our nation's schools of engineering.

We must direct our innovative energy to seeing and seizing upon the latest areas of innovation that will help us maintain our position of international leadership. The area of nanotechnology is such an area.

In order to compete globally in the research, development and manufacturing of nanotechnology in the future it is necessary for the educational system in Virginia to produce large numbers of highly educated personnel and to support the continuing education needs of working professionals. Overall science and technology education trends in the U.S. however are in the opposite direction. Here are a few of the facts as noted by the National Academies of Science's study released in October of 2005 entitled; "**Rising Above The Gathering Storm**:. Energizing and Employing America for a Brighter Economic Future". This study can be read at the following site: http://www.nap.edu/catalog/11463.html

- In South Korea, 38% of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47%, in China, 50%, and in Singapore 67%. In the United States, the corresponding figure is 15%.

- Some 34% percent of doctoral degrees in natural sciences and 56% of engineering PhDs in the United States are awarded to foreign-born students.

- In the U.S. science and technology workforce in 2000, 38% of PhDs were foreign-born.

- Fewer than one-third of U.S. 4th grade and 8th grade students performed at or above a level called "proficient" in mathematics; "proficiency" was considered the ability to exhibit competence with challenging subject matter. Alarmingly, about one-third of the 4th graders and one-fifth of the 8th graders lacked the competence to perform even basic mathematical computations.

- U.S. 15-year-olds ranked 24th out of 40 countries that participated in a 2003 administration of the Program for International Student Assessment (PISA) examination, which assessed students' ability to apply mathematical concepts to real-world problems.

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- In 1995 (the most recent data available), U.S. 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science.

To prepare the necessary workforce, education needs to be addressed at all levels. The National Academies Gathering Storm report provides some excellent recommendations for addressing these educational needs and the federal government is pursuing legislation to implement many of the report's recommendations. (A current status on the U.S. Congress activities to address the report's recommendations can be found in the power point labeled "Report" located at the following National Academies website: http://www7.nationalacademies.org/gatheringstorm/index.html) It is up to the Commonwealth to do its piece to align with these federal activities and ensure that current and future educational initiatives in the Commonwealth represent a truly comprehensive program for driving science, technology, engineering and mathematics (STEM) education in Virginia.

In order to implement a comprehensive STEM plan and make an impact on the future of K-12, a set of tangible curriculum supports must be developed and delivered to the superintendents of school systems in the Commonwealth. These tangible activities that align with the National Standards as well as with the Virginia Standards of Learning have to be presented to superintendents, district level curriculum supervisors and building level administrators demonstrating that this comprehensive program will be a vehicle with which to deliver instruction and at the same time enhance the curriculum. Subsequently, the curricular activities that are integrated in this plan will stimulate interest in teachers and make them feel the desire to learn more about STEM supplemental activities that will not only excite students about science, technology, engineering and mathematics, but at the same time increase their students' analytical and critical thinking skills. Through the implementation of this K-12 comprehensive program, teachers will have the opportunity to engage students in solving scientific problems and provide the foundation of skills that will allow them to achieve success from postsecondary education all the way through their career.

In K-12 outreach several Commonwealth universities are pursuing their own programs, each with a different approach. Many companies involved in the nanotechnology industry are also pursuing outreach programs of various types. While each of these activities is valuable and has significant impact, a more collaborative effort could be created across the university system with the additional goal of getting industry involvement. The Commonwealth's K-12 STEM plan should build upon these elements. Virginia should consider partnering with industry to create programs with common goals for driving STEM education so the Commonwealth's actions can be further amplified. Perhaps the Commonwealth should create its own version of the Gathering Storm action list in order to have a coherent plan that Government, Universities and Industry can rally behind. Science, Technology, Engineering and Math education will be the foundation upon which the nanotechnology industry continues to build.

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Even with a coherent program focused on developing strong STEM skills in grades K-12 across the Commonwealth, additional focus needs to be maintained on developing programs supporting current engineering technologies and emerging technologies such as nanotechnology. Community colleges will be critical, not just for training technicians, but for educating students working toward transfer to four year or advanced degrees. The Commonwealth's colleges and universities will need to continue and expand their nanotechnology offerings in related science and engineering disciplines for degree, minor, and certificate programs.

Currently, there are many nanotechnology education initiatives underway with focus on developing future candidates for employment in the industry as well as providing for continuing education opportunities for the current workforce. At the community college level there are several actions already being pursued with the Virginia Community College System. Danville Community College is working with Luna nanoWorks to develop a technician training program focusing on the needs of nanomaterials manufacturing, Northern Virginia Community College is working with Micron Technology to develop a manufacturing technician certificate program to allow for the hiring of production employees that can work in a highly automated production environment and Qimonda presently has a tech training program in operation with the J. Seargant Reynolds Community College. On October 19, 2006, U.S. Secretary of Labor Elaine L. Chao announced the awarding of $16.8 million in grants to 11 organizations in 10 states to prepare workers for careers in advanced manufacturing. The eleven organizations were selected from among 186 applicants competing under the President's High Growth Job Training Initiative. An Advanced Manufacturing grant committee comprised of industrial members of the Virginia Biotechnology Association, the Virginia Manufacturing Association and the Virginia Community College System was one of the eleven groups that received an award of $1.5 million to address the further development of Manufacturing Technician training in the Commonwealth.

At the university level there are multiple activities and continuing needs. Several universities have NSF Research Experience for Teachers (RET) and Research Experience for Undergraduate (REU) programs. These are often tied to research centers or large research programs that give teachers or undergraduate students an opportunity to conduct research in the laboratories during the summer. The undergraduate programs have been quite successful, drawing students from across the country to our research institutions. In the RET programs, however, it is often quite difficult to find enough teachers interested in participating to fill the available slots. In a comprehensive STEM plan created and well communicated in the Commonwealth education providers should be more motivated to pursue these types of educational opportunities.

At the undergraduate level, there are several courses being offered that focus on nanotechnology. Several universities have received Nanotechnology Undergraduate Education awards from NSF, including JMU, VT, and UVA. These programs enable the development of classes and/or laboratories that focus on nanotechnology. The program at James Madison University has integrated nanotechnology throughout the chemistry curriculum. A unique aspect of their program is the use pre-service science teachers

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(upper level teaching students) as laboratory assistants in the nanotechnology laboratory classes to give them exposure to nanotechnology as well as experience running a lab. The organization and operation of a chemistry laboratory is often a difficult skill for new teachers to obtain and master. This program not only impacts the chemistry students at JMU, but the middle and high school students that are subsequently taught by the trained teachers also benefit and the exposure to nanotechnology is much broader.

Another key need for the continuing education of the current workforce in the Commonwealth is the development of asynchronous undergraduate engineering degree programs to support several engineering disciplines. This type of program is required to support the increasing needs of working professionals in Virginia's nanotechnology, microelectronics, energy, and automotive industries who want to pursue Bachelors degrees while working shift schedules or are located remotely from educational providers. These programs require a significant commitment of resources but would support continued professional development needs across the Commonwealth.

Graduate level nanotechnology courses are being offered as part of the science and engineering curriculum at multiple Commonwealth engineering institutions. The recent National Science Foundation Partnership for Innovation ($600,000) grant awarded to George Mason University, the College of William & Mary, Old Dominion University, the University of Virginia, Virginia Commonwealth University and Virginia Tech will help lay the foundation for shared graduate level nanotechnology courses through the Commonwealth Graduate Engineering Program (CGEP). CGEP also received some funding from the Commonwealth of Virginia this year in support of this program to deliver shared nanotechnology courses for its member institutions and industry. Expanding the CGEP graduate engineering education program to a full asynchronous capability would benefit working professionals. By driving Virginia's educational system towards more flexibility for the continuing education of our current and future workforce the Commonwealth will continue to advance towards a leadership position in the development of the nanotechnology industry.

To concatenate these programs, alignment vertically and horizontally regarding nanotechnology-based education within the Commonwealth is needed. A centralized plan with oversight for all activities from K-12 to graduate would position Virginia as a national leader in this emerging scientific field. It is expected that this effort will:

- stir student's interest in being a part of the coming nanotech-boom,
- receive broad community involvement,
- give long-term motivation,
- support a STEM push,
- give students deserved recognition, and
- fit into a well received media strategy.

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