

A Regional Response to  
**RISING ABOVE THE GATHERING STORM**

# The STEM Talent Development Forum

A DIALOGUE FOR ACTION

Setting the Stage for U.S. Competitiveness through  
Science, Technology, Engineering and Math Education

June 26-27, 2006  
Philadelphia, Pennsylvania

**PROCEEDINGS**





## **It's Time to Act**

The first steps of a long and exciting journey are often accompanied by a sense of pride, anticipation and cautious optimism. These were exactly my feelings throughout the proceedings of the first STEM Talent Development Forum. By the Forum's conclusion, I was also feeling a great energy, as the organizations in attendance took the first steps towards our shared vision of a future of extraordinary promise and potential.

That vision is one of a region, and a nation, of innovators, leaders and entrepreneurs capable of developing new ideas, creating breakthrough technologies, and propelling local, state and national economies to ever-higher levels of competitiveness on a global scale. Education in the critical areas of science, technology, engineering and math will be the fundamental force that drives success. It must begin at the earliest age, it must be sustained for a lifetime – and it must begin now.

As evidenced by the commitment shown by our Forum participants, that process of enhancing education has indeed begun. We have started the dialogue, and taken important steps on the path to sharpening minds, encouraging creativity and opening new doors to opportunity.

On behalf of the DVIRC, I want to thank our participants for their leadership, and invite others to join in that vision for our region – as we work to create an intellectually powerful workforce, and move forward towards a future of progress and prosperity.

A handwritten signature in black ink that reads "Joseph J. Houldin". The signature is fluid and cursive.

**Joseph J. Houldin**  
Chief Executive Officer  
DVIRC





# Proceedings

## STEM Talent Development Forum A Dialogue for Action

### FOREWORD

How adept we are in anticipating the future and shaping it to our needs will determine how well we are able to meet the novel, and as yet unknown, challenges of the future. We can be certain, however, that our capacity for this task depends foremost on the education of our citizens. Philadelphia's paramount inventor, scientist and entrepreneur, Benjamin Franklin, in his autobiography, a journey of his self-education, counseled our then-nascent nation saying: "Let the citizens of America ... encourage institutions calculated to diffuse knowledge amongst the peoples." Franklin's *Poor Richard's Almanac*, in 1750, likewise touched on the importance of education with the aphorism: "Genius without education is like silver in the mine."

Franklin's words cascade in importance today as global markets ignite the quest for new wealth as the world's citizens seek a better life. The lesson is clear for America: - now that fast-paced transformation is our common currency, now that new technologies and whole industries emerge in what seems like the blink of an eye, now that innovation is an imperative for continued prosperity, Franklin's admonition equally impels us to realize that if our nation does not succeed in getting the education equation right, we are headed for failure despite our continued aspirations of greatness.

The empires of the future  
will be empires of the mind.  
Winston Churchill

Today, new paradigms of technology, communication, and work design are changing the rules of the economic system we have come to know and which have served us well. In describing this disruption, what Pulitzer-prize winning journalist Tom Friedman calls "the flattening world," we are confronted with a world both extraordinary and simultaneously exciting, but also

at times painful.

Nonetheless, the world is in our laps and demands our attention. In a sense, this transformation of our world of work, knowledge,

and technology is natural in a vibrant, free and open society where new ideas continually bubble up and foster change. Our nation's policy of investing its resources in probing the frontier for new knowledge to enable new enterprises is a successful formula for creating fresh wealth and new jobs but only if the citizenry is educated. Knowledge is inherently human — the formula breaks down at the front end if the citizenry is not educated to probe the frontiers of knowledge, and it risks obsolescence if citizens are not educated to carry new ideas to fruition and sustenance in the economic marketplace.

In the past few years we have witnessed a wave of forceful and compelling studies and trend analyses that have addressed critical aspects of this issue. Taken together, these reports provide a persuasive

picture of what is going on in the world marketplace of ideas, the economy and the workforce. They all focus on innovation. In the words of the late Peter Drucker, the pioneer of modern management theory who coined the phrase, “knowledge worker” - "the process of creating new knowledge and applying it to things that are new and different." The evidence is also clear in validating what we see when each entrepreneurial success is analyzed: - that the dynamic integration of talent, investment, and infrastructure is what makes innovation work.

Innovation depends intimately on our ability to discern patterns and sequences within the natural turbulence of ideas; thus, innovation is always about imagination, about putting new knowledge to things that are new and different resulting in enterprises that create wealth and jobs. While these enterprises cannot be born without the new knowledge generated by people doing research, they cannot succeed in providing prosperity without the people who make, manage, and move products cleanly, safely, efficiently and sustainably. In this sense, economic success will not be achieved by those who simply make commodities faster, cheaper, and better than the competition. Success will be earned by those who continually develop talent, techniques, and tools so advanced that competitive capability can be sustained robustly.

In America, overarching the focus on innovation is a formidable competitive advantage — capitalizing on the nation's great diversity. In today's world, the ability to make sense of the complex is to value the perspective of diversity and inclusiveness. This is a global competitiveness factor of high order. If we fruitfully employ the differences that diversity brings and mute the divisions, our country can remain intellectually and strategically formidable. Thus, our growing diversity is a critical element of our future greatness. Our nation's high school dropout rates are unsustainable in light of a job environment that requires not only graduates but astute, imaginative

graduates who are intellectually capable and can meet the expectations of jobs that do not even yet exist. Imagination is a defining feature of the fast-paced turbulence of the present and increasingly so for the faster-paced future. Since innovation is about imagination, and diversity brings with it all manner of imaginative perspectives, it is imperative that we mine the silver in all our citizens' minds.

Innovation moves us forward earnestly if hand-in-glove with new science and engineering knowledge. Guided by the recent documents addressing our competitiveness issues with a focus on science, technology, engineering, and mathematics (commonly referred to as STEM), these Forum Proceedings present one example of a regional community coming together to consider the diverse perspectives and recommendations and to develop ways to carry them out. Education, discovery, and innovation are the pillars of 21st century progress. Coupled together in trusted partnership between industry, academia, and government, they offer the potential of breathtaking transformation, produced by all of us and enjoyed by all of us.

### **Raj Gupta**

Chairman, President & CEO  
Rohm and Haas Company

### **Dr. Joseph Bordogna**

Alfred Fidler Moore Professor of Engineering  
University of Pennsylvania

### **Michael J. McPhilmy**

Vice President Human Resource Development  
Southco, Inc.





**Proceedings**  
**STEM Talent Development Forum**  
**A Dialogue for Action**

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## EXECUTIVE SUMMARY

### Purpose

The Science, Technology, Engineering and Math (STEM) Talent Development Forum was convened by the Delaware Valley Industrial Resource Center and the National Council for Advanced Manufacturing on June 26-27, 2006 at the Hilton Philadelphia Airport Hotel. More than 170 representatives from business, education, government, economic development and other institutions and associations participated.

Subtitled “A Dialogue for Action”, the Forum was held to bring the national conversation about the critical role of education in American competitiveness to the regional level, and more importantly, galvanize the region’s institutions into creating a collaborative action agenda to promote STEM education.

In response to the National Academies’ landmark report *Rising Above the Gathering Storm*, the Forum focused on one of the report’s major recommendations: Increase America’s talent pool by vastly improving K-12 science and mathematics education. This recommendation supports our broad regional goal of increasing enrollment in STEM education at both the secondary and post-secondary levels.

The three major goals of the Forum were to:

1) **Advance the dialogue** about what regional business-education collaboratives can do now to ensure that the region’s and the nation’s education systems will provide a continuous supply of highly-trained technicians, technologists, engineers, mathematicians and scientists. This, in turn, will teach the U.S. to safeguard its global economic leadership;

2) **Identify successful local, regional and state-level program models** that can be used by regional collaboratives to attract K-12 students to STEM-related careers and to strengthen K-20 STEM education programs; and

3) **Articulate actions** that can be taken at the local, regional and state levels to develop focused support for STEM education in K-16 systems so that businesses have the talent they need to compete more effectively in the global marketplace.

### Key Recommendations

*The top recommendations for action distilled from the Forum and from post-Forum participant feedback include:*

- **Form a Regional Compact for STEM Education.** This Compact will facilitate the implementation of Forum recommendations by coordinating the efforts of the National Science Foundation- funded Math/Science Partnership of Greater Philadelphia, the Philadelphia Math and Science Coalition, the Department of Labor-funded Applied Engineering Technology project, and others.



Tony Girifalco, Executive Vice President, DVIRC

- **Involve Industry in Shaping STEM-Related Education Programs.** The focus should be on encouraging the development of curriculums that incorporate STEM programs in grades K-12 and in college/university programs that are directly tied to business needs. At the same time, opportunities should be created for keeping STEM K-12 and college/university faculty current in their fields.
- **Increase Enrollment in STEM Education.** Efforts should be coordinated to increase enrollment in STEM programs throughout the region, including enrolling 10,000 students in the region's Applied Engineering Technology programs by 2010.
- **Develop a Plan.** Set quantitative and aggressive regional performance and outcome measures that includes the following elements:
  - **Taking Inventory.** Take inventory of what is happening regionally and nationally and disseminate it – then find funding to replicate and bring to scale the best formal and informal practices/models from within the region and across the country.
  - **Developing a Research/Evaluation Infrastructure.** Create a research/evaluation infrastructure to gather relevant regional research findings and statistical reports that document and quantify the work of the Compact and the return on investment for the region.
  - **Developing a Communications Strategy.** Develop a communications strategy to increase enrollment, to insure that key messages are consistently conveyed, and to keep all audiences current and involved.
  - **Supporting Teacher Development.** Develop a regional approach to supporting the creation and ongoing development of STEM teachers.
  - **Transforming Teaching.** Seek ways to radically transform teaching through technology-based and applied learning with input from STEM professionals.

## Next Steps

### Regional Compact for STEM Education

*These key partners have agreed to develop and sign a Regional Compact for STEM Education:*

- The Math/Science Partnership of Greater Philadelphia
- The Philadelphia Math and Science Coalition
- The Applied Engineering Technology project
- WHYY
- Select Greater Philadelphia

This initial group of partners will seek the help and support of any and all other institutions, organizations, and associations interested in STEM education. Please see Appendix A for the list of institutions and organizations represented by these initial partners.

## Briefings

*Briefings have been requested by the following Forum participants:*

- The Honorable Curt Weldon, U.S. House of Representatives and SMART Delegation
- The Honorable Emily Stover DeRocco, U.S. Department of Labor Employment and Training Administration
- The Honorable Dennis Yablonsky, Pennsylvania Department of Community and Economic Development

## Forum Evaluation

*To two key questions in the on-site electronic evaluation, respondents indicated as follows:*

Question: Do you feel important work has been accomplished?	Excellent <b>47%</b>	About Right <b>53%</b>
Question: Do you feel your attendance was worthwhile?	Yes <b>100%</b>	No <b>0%</b>



# Proceedings

## STEM Talent Development Forum

### A Dialogue for Action

June 26-27, 2006

## FORUM AGENDA

### Setting the Stage for U.S. Competitiveness through Science-Technology-Engineering-Math Education

**Pre-work.** A Briefing Book summarizing recent research and reports was sent electronically to all participants in advance of the Forum. Hard copies were also available at the event. The Honorable Curt Weldon spoke by phone to the participants that were able to attend an evening reception about the importance of STEM education and of the importance of the region's need to take ownership of this issue and the actions that come out of the Forum. He offered to convene the elected officials of the SMART region (PA, NJ, DE, MD) for a briefing on the results.

#### Day One June 26, 2006

6:00 – 7:30 pm Special remarks: The Honorable Curt Weldon (R-PA)

#### Day Two June 27, 2006

8:30 am Welcome: Bernadine Hawes, DVIRC Board Chair

Forum Overview and Roundtable Objectives:

Joseph Houldin, CEO, DVIRC

Eric Mittelstadt, CEO, NACFAM

8:40 am Keynote Remarks

Honorable Emily Stover DeRocco

Assistant Secretary, Employment and Training Administration,  
U.S. Department of Labor

9:00 am Panel # 1  
Meeting the Science-Technology-Engineering-Math Education Challenge

10:15 am Panel # 2  
Building a World-Class Education and Training System to Support Private  
Sector Innovation

11:00 am	<p>Panel # 3 Assuring the Global Competitiveness of the U.S. High-Tech Sector</p>
12:30 – 1:10 pm	<p>Lunch &amp; Luncheon Address The Honorable Dennis Yablonsky Secretary, Department of Community and Economic Development Commonwealth of Pennsylvania</p>
1:15 – 4:45 pm	<p>Roundtables</p> <p>Attendees participated in a series of roundtable breakout discussions. Roundtable leaders were asked to frame their topics within a series of questions that were distributed in advance of the Forum. The following roundtable sessions were held:</p> <ul style="list-style-type: none"> <li>• Engineering Deans’ Roundtable</li> <li>• Building student interest in STEM-related careers</li> <li>• Integrating STEM-related programs at the secondary and post-secondary levels</li> <li>• Developing STEM-related professional development programs for K-12 teachers</li> <li>• Integrating incumbent worker education and economic development</li> <li>• Identifying programs, methods and tools students need to master STEM</li> <li>• Sector issues/approaches to deal with STEM education</li> <li>• STEM and Economic Development education</li> </ul>
4:50 – 5:15 pm	<p>Roundtable Report-Out Session - Action Plan</p> <p>Roundtable Action Plans were summarized and presented at the Report-Out Session to permit attendees to observe what they accomplished during the Forum and to pose any questions they might have and suggestions for next-steps.</p>
5:15 – 5:30 pm	<p>Closing</p> <p>The closing moderator highlighted the dissemination strategy, the plan for distribution of the Forum final report, and the next steps that should be taken to replicate the STEM Talent Development Forum in other regions of the U.S.</p>

## KEYNOTE ADDRESS

### The Honorable Emily Stover DeRocco

Assistant Secretary, Employment and Training Administration, U.S. Department of Labor

Thank you. It is always a pleasure to be back in my home state, particularly focusing on a subject as important as math and science education. The Delaware Valley, and many other regions around the country, have correctly identified STEM education and the development of STEM talent as critical to the success of their economy.



Over the past year and a half or so, three publications have brought this issue to the front of our agenda. The first was a report issued by the Council on Competitiveness titled, *Innovate America*. Leaders from business, academia, and government came together under the Council umbrella to identify a series of steps required to maintain U.S. leadership of the global economy. Each of these steps was based on the premise that the U.S. must drive innovation if we are to maintain our leadership. We must always be in search of “the next big thing.”

This was then built upon by the National Academy of Sciences [NAS] report, *Rising Above the Gathering Storm*. In it, NAS specifically identified STEM education as the prerequisite to innovation and encouraged action to improve STEM education in our nation’s high schools.

Finally, the one that put this into context and gave name to our era was Tom Friedman’s opus, *The World is Flat*. It offered specific examples of the effects of globalization around the world and warned of the consequences that it may have on Americans.

These works were critical because they focused the mind of the public and the policy makers on the

economic realities of the day. Globalization has brought many new countries, representing nearly half the world’s population, into the economy. Some of these countries are in a race to the bottom, competing fiercely to steal the lowest skilled, lowest paid jobs in the world for their citizens. While that may be appropriate for China or Indonesia or Thailand, it is clearly not our destiny. We want to attract, and create, the highest skilled, highest paid jobs in the global economy. And science, technology, engineering, and mathematics are the foundation of those jobs.

Of course, there are competitors for these jobs as well. Western Europe has become something of a case study in how not to grow your economy. But recent difficulties aside, there is tremendous strength in these countries. Germany is still the world’s largest exporter of goods, in no small measure because of their engineering prowess. And the U.K. trails only the United States in delivering services to the world.

While Europe represents the established competition, the Far East and the Sub-Continent provide the emerging one. Most of us are familiar by now with China and India and the progress they have made. India in particular sees its future not in competition with China for low-skill manufacturing, but in competition with the West for services. There are others too. South Korea has the most advanced wireless network in the world, providing access over cell phones to things Americans only dream about right now. And even Japan, awaking after a 15-year slumber, is once again driving the electronics market. So as the world’s other leading and emerging

Over the next few years, 26 of the top 30 fastest-growing jobs will require some post-secondary education or training. The demand for skilled workers is outpacing supply, resulting in attractive, high paying jobs going unfilled.

Emily Stover DeRocco

countries join the market, the United States must redouble its efforts to maintain our leadership. And we have much work to do.

It clearly starts in our nation's K-12 schools. If students are to move on to demanding engineering and computer science programs in college, they must establish the foundation in high school through rigorous courses in math and science. And that challenge is not even taking into account the fact that only two-thirds of high school freshman will graduate on time.

It is this absolute need for improved high school education that is at the heart of President Bush's new Competitiveness Agenda. Increasing the resources and focus on Advanced Placement courses in math and science, and providing for area professionals to teach at high schools, are important steps in providing our nation's youth with the basic skills needed to pursue an education in these fields.

As we improve the education available to these students, the parallel challenge is attracting them to these courses. We've all heard the complaints from our children, or made them ourselves, about how we'll never use algebra or calculus in our day-to-day lives. But engineering and technology fields are built on these disciplines. It is a matter of connecting what students learn in school to the real world.

I understand that someone from Project Lead the Way is here today. And I know Future Cities is here. These are examples of programs that seek to do exactly that, introducing students to the scope and opportunities of engineering. While these programs are on the ground in individual school districts, we at the Labor Department are interested in seeing those programs brought to scale and trying to provide some tools that will hopefully assist in career exploration and connection. Specifically, we have partnered with the McGraw-Hill Publication Company to create a magazine series aimed at students called, In Demand.

As you can see, this is a teenage-focused magazine that interviews young professionals to whom students can relate and describes the pathways needed to reach those careers, along with what you can expect to make in those jobs. We already published issues on construction, energy, advanced manufacturing, and health care, and distributed over one million copies to every high school in the country. This fall, we are going to begin the new school year with a special edition on STEM careers.

While the focus on high school education is important for building the future STEM workforce, it is by no means the only activity that we should be undertaking in support of STEM education. Recent Labor Department projections show that fully 90 percent of the fastest-growing jobs will require education and training beyond high school. And two-thirds of all new jobs in the next decade will require a college education, though only one-third of the population currently holds such a degree.

In addition, there are many industrial sectors, particularly in manufacturing, that are undergoing tremendous transformation. Individuals working in these fields have a basic skill set required for employment in new economy STEM fields, but need some additional education and training to be fully prepared to enter these jobs.

As I like to say, education is no longer K-16; it is now K through Gray. The speed and complexity of the new economy will require all of us to continually update our skills to keep pace, and our traditional educational institutions must be prepared for this new breed of adult learner. Specifically, I am thinking of community colleges. Given their nature and design, they are best suited to respond quickly to the changing economic environment, and can adapt and customize courses to provide the training needed to help adults prepare for and enter new economy fields. The Labor Department has been supporting these programs through our Community College Initiative, issuing \$125 million in grants last fall and preparing a new solicitation to be issued in a matter of days.

It isn't just community colleges though that must respond to the challenge. Universities are where the most rigorous and in-depth STEM education is found and they too must become innovative in serving people outside the traditional 18-22-year-old students. Technology now allows many different opportunities for people of all ages and I know that universities are exploring these options as ways to reach greater numbers of people.

Universities are particularly important because they are now playing a larger role in the competitiveness of a region. When we think of the most successful regional economies in the country — Silicon Valley, Research Triangle, Boston — they all have major universities as their hubs. Philadelphia is perfectly positioned to join this list. With the breadth of universities in this region, and represented in this room, you have a tremendous advantage over many other regions in the country.

Of course, building or transforming a regional economy takes more than top flight universities. All the major economic assets in the region must play a role. This includes the business and economic development organizations, the financial assets as represented by angel investors, venture capital firms, and foundations, and the whole continuum of education and talent development institutions, including the public workforce investment system.

Part of the President's American Competitiveness Initiative is an important proposal to direct more resources to tuition assistance through Career Advancement Accounts that would help the workforce system contribute more significantly to the development of STEM talent.

And of particular concern to this region is the alignment of federal, state, and local governments. We often do not view government as being an asset in a region, but they are a major component of an economy. If the feds, state officials, and local representatives are working against each other or at cross-purposes, then they become a liability, a drag on the region's economy. But alignment of these levels of government can provide an amplifying effect to regional economic development efforts. We are in alignment now, particularly on STEM issues. This is the time for a bold agenda, the time to act.

It is precisely this alignment of economic and talent development that we seek through our WIRED Initiative. By coordinating regional assets to improve talent development, regions can create the workforce that builds and attracts companies that will drive the 21st economy.

The Delaware Valley is already well on its way to building such a regional economy. The growing sectors of life sciences, pharmaceutical, and advanced manufacturing you now possess can lead this region to the economic growth that once made Philadelphia the largest city in the English-speaking world. Of course, to reach that potential requires a world-class STEM-educated workforce.

I am happy to see so many leaders in the room today dedicated to creating that workforce and I am committed to helping regional economies across this country achieve that goal. My team is here for the duration. Their instructions are to come home with a strategic action agenda. That agenda begins today.

Thank you.

## PANEL DISCUSSION SUMMARY



### Moderator

#### **Dr. Joseph Bordogna**

Dean Emeritus, Alfred Fitler  
Moore Professor of Engineering  
University of Pennsylvania

### Panel 1 – Meeting the Science-Technology-Engineering-Math Education Challenge

#### **Panelists:**

Eric L. Flicker, P.E., Chief Financial Officer & Treasurer, Pennoni Associates, Inc.

Dr. Gary Cooper, Superintendent of Schools, Radnor Township, Radnor, PA

Dr. P. Roy Vagelos, Retired Chairman and CEO, Merck & Co., Inc. Member of the NAS Committee that published “Rising Above the Gathering Storm”

Education is the gateway to opportunity and the foundation of a knowledge-based, innovation-driven economy. For the U.S. to maintain its global economic leadership, we must ensure a continuous supply of highly trained mathematicians, scientists, engineers, technicians, and scientific support staff who are scientifically, technically, and numerically

literate. To increase America's talent pool, we must vastly improve and support K-20 education in the areas of science, technology, engineering, mathematics, creative thinking and collaboration.

#### **Questions discussed by panelists:**

- How critical is the “STEM challenge” confronting the U.S.?
- What actions must be taken by policy makers to raise the STEM challenge to the top of the stakeholders’ priorities list?
- How can students and adults be motivated to pursue STEM-related careers?
- What steps must be taken to increase the number of college students that enroll in STEM-related graduate programs?

### Issues raised by attendees:

- If the message needs to get out to the general public, how do we achieve this and pull from the full labor pool to support the nation's needs, not just K-12? In addition, how do we deal with the challenge of globalization, its impact on jobs to the worker, and the need to communicate that STEM is critical to current and future jobs?
- Would it be a realistic goal to change the K-12 system to allow industry professionals to become teachers without getting certified? (i.e. professional engineers, biologists, chemists, etc.)
- Should we continue to advance K-12 students in STEM programs who are not competent in the subject matter, or create meaningful standards and enforce them?
- How do you take some of the strategies identified in this Forum and put them into action? Where has it worked? How can we get over "not invented here?"
- How many STEM-qualified graduates do we need?
- How many lawyers, accountants, political scientists and economists?
- By the time students reach high school, isn't it too late to develop an interest in STEM-related subjects?
- Should all our resources be applied to graduating the STEM-qualified grads?
- Do we need an amendment to the U.S. constitution making the federal government responsible for K-12 education?
- How can we hope to solve the issues surrounding motivating younger people around STEM without involving them (the customers) directly in dialogues such as the one here today?
- What do we do to keep our undergraduate and graduate STEM students in our region's labor market? This region has a major problem with not keeping its students after college – they leave.

### Key Observations by Panelists:

- U.S. students' deficiencies in STEM education can only be solved by placing this "crisis" at the fore of the national policy agenda (moving issues such

as healthcare and social security below STEM issues); a movement akin to the "Sputnik" mentality of the 1960s is again needed.

- A systems approach to revitalizing interest in STEM education is needed. Traditional 20th Century approaches to curricula development and implementation (timed instructional periods, lectures, isolated and fragmented approach to specific disciplines) must be replaced with project-oriented, interdisciplinary and critical-thinking based instruction where both academic/technical knowledge and communication/soft skills are equally presented.
- Funding for STEM education must begin with funding early childhood and basic education.
- A cultural and social movement that supports STEM education and STEM-related professions must begin with more concerted efforts to include women and minorities, as well as experts from industry supporting the movement via use of adjunct professors. Particular attention must be paid to demonstrating the importance of STEM-related careers and not based solely on corporate philosophies of individual and company wealth.



From Left to Right: Eric L. Flicker, P.E., Chief Financial Officer & Treasurer, Pennoni Associates, Inc.; Dr. Gary Cooper, Superintendent of Schools, Radnor Township, Radnor, PA; Dr. Jerry Parker, President, Delaware County Community College

## Panel 2 – Building a World-Class Education and Training System to Support Private Sector Innovation

### Panelists:

Dr. Arden Bement, Director, National Science Foundation

Jennifer McNelly, Director of Business Relations Group, Employment and Training Administration, U.S. Department of Labor

Dr. Jerry Parker, President, Delaware County Community College

Joseph Welsh, Executive Director, Life Science Career Alliance

The bedrock of U.S. competitiveness is a well-educated and skilled workforce, especially in the fields of science, math and engineering. To help students succeed in their classrooms, we must introduce greater accountability and high standards of achievement, increase teacher professional development, recruit teachers with mastery of content, develop research-based curricula, and provide greater access to flexible resources for worker training. By engaging students in rigorous courses that teach important analytical, technical, integrative, and problem-solving skills, we will prepare them to compete more effectively in the global marketplace.

### Questions discussed by panelists:

- How can colleges and universities improve the education of prospective teachers in STEM-related subject areas?
- What must be done to enhance the skills of current K-12 teachers in STEM-subject areas?
- What improvements must be made in curricula to increase secondary and post-secondary student interest in STEM-related careers?
- What kind of incentives can be offered to increase student enrollment in STEM-related teaching careers?
- How can government-funded education and



From to Left to Right: Dr. Joseph Bordogna, Dean Emeritus and Alfred Filter Moore Professor of Engineering, University of Pennsylvania; Jennifer McNelly, Director of Business Relations Group, Employment & Training Administration, U.S. Department of Labor; Dr. Arden Bement, Director, National Science Foundation

training programs be improved to encourage incumbent and/or dislocated workers to acquire new STEM-related knowledge and skills?

### Issues raised by attendees:

- What do we need to do in STEM for workers over 55 in the coming years considering the baby boom demographics? (Given the increase in life expectancy for Americans, and the social issues we face in MEDICAID and Social Security, it is reasonable that people may have/need a productive work span that stretches well beyond the industrial age definition of retirement.)
- Do you believe our math and science teachers could benefit from closer collaboration with career and technical education teachers in a process to engage students (and themselves) in more "real world" practical application of math and science?
- Given industry is identified as the beneficiary of the innovators the education system creates, and

the community supplies raw materials (students/workers) as well as financing for training, what is industry's obligation to the educational system and the community?

- In what ways must STEM education change so that graduates are prepared to support engineering design, innovation, and entrepreneurship?
- Robust career development of STEM teachers is needed — more opportunities for these teachers to work in industry over the summer to keep a "real world" perspective on their field.
- STEM-related professional development for Principals/School Administrators is also key.
- How can industry engage?

#### Key Observations by Panelists:

- Prospective STEM teachers need to be provided with education and training that integrates content and pedagogy; and, most importantly, emphasis must be placed on holding individual educators responsible for lifelong professional development.
- Funding for STEM-related initiatives must funnel to the programs that support private sector innovation (this may not be the case presently, from an overall systemic analysis).
- Discovery/inquiry/hands-on based curricula is the best way to support private sector innovation, as they would mirror how innovation occurs.
- STEM Education and Training that supports private sector innovation must become a critical component of all traditional areas of education (e.g., liberal arts, etc.)

### Panel 3 – Assuring the Global Competitiveness of the U.S. High-Tech Sector



From Left to Right: Dr. Gary Cooper, Superintendent of Schools, Radnor Township, Radnor, PA; Jerry Parker, President, Delaware County Community College; Dr. Roy Vagelos, Retired Chairman and CEO, Merck & Co., Inc.

#### Panelists:

Dr. Arden Bement, Director, National Science Foundation

Linda Fowler, Senior Analyst, NIST Manufacturing Extension Partnership Program, U.S. Department of Commerce

Dr. P. Roy Vagelos, Retired Chairman and CEO, Merck & Co., Inc. and Member of the NAS Committee that published "Rising Above the Gathering Storm"

Keeping our competitive edge in the ever-changing world economy requires public policies that will assure continued leadership in innovation, exploration, and ingenuity. This nation's ability to generate and harness the latest in scientific and technological developments will depend on having a K-12 education system that equips each new generation with the educational foundation needed for future study and inquiry in technical subjects. It

will require a training system that equips our workers with the skills necessary to transform new ideas into improved goods and services.

#### Questions discussed by panelists:

- How can new STEM-related education investments help K-12 students and workers reach their full potential so they can unleash their creativity and ingenuity and push the boundaries of U.S. scientific and technological capabilities?
- What must be done to attract the best and brightest students and workers, and thereby keep the U.S. at the forefront of science and technology?
- How will raising the focus on STEM-related education enable the U.S. to maintain its competitive edge and remain the premier place in the world for innovation?
- What steps must we take now to guarantee that in the future the U.S. will have the advanced scientific and technological excellence it needs to compete successfully with any nation around the world?

#### Issues raised by attendees:

- Do we need a National Engineering Foundation to support applied engineering research to complement basic research supported by NSF?
- It seems that the panel # 3 title needs to be rephrased to – “Assuring U.S. Competitiveness in the Global High-Tech Sector.”

#### Key Observations by Panelists:

- Funding for STEM-related research and training and education for STEM-related teaching professions must increase drastically for the U.S. to assure and retain its preeminent position in the global marketplace.
- Integrating education and research (the long-standing NSF model) must continue
- By offering internships abroad for U.S. students in STEM-disciplines, as well as offering “reverse Rhodes Scholarships” bringing the best STEM-students from around the world, develop an international network of ideas and trade.

According to the Bureau of Labor Statistics Science and Engineering occupations will increase about 70% faster than the overall growth rate for

- Ensuring the competitive preeminence of the U.S. High-Tech sector in the global economy absolutely requires a totally inclusive recruitment initiative bringing in minorities, women, and students from all socioeconomic, ethnic, and demographic walks of life. We must mirror the global marketplace when focusing on recruiting talent in STEM-related fields.

## LUNCHEON ADDRESS

### The Honorable Dennis Yablonsky

Secretary, Department of Community and Economic Development,  
Commonwealth of Pennsylvania

I'm going to talk about some things that are little bit broader than the STEM issues that you're discussing today, although STEM will be a part of my comments.

I want to go a little bit broader and I want to thank and congratulate initially the DVIRC and the National Council for Advanced Manufacturers for pulling everybody together. I think the time for studying this issue is over and the time for action has begun. There is more data than we need to make decisions about what to do. As an entrepreneur, I have a bias towards action.

We need to be absolutely bound and determined in the Commonwealth of Pennsylvania to turn our manufacturing fortunes around and stop the bleeding that has occurred. Innovation both in terms of human resources as well as product and process activity is the core. A new report titled *Manufacturing Tech Formation* has been released on Growth Strategies for Manufacturing Innovation in Pennsylvania. It's the culmination of a lot of effort, including collaboration with the IRC community, our views and going-forward strategy.

Most people don't realize how large our economy is. It's a \$450 billion gross state product. That's the 6th largest in America and it's the 17th largest in the world. It's larger than most nations and it's a very diverse and complicated economy that historically was built around industrial assets.



There are 5.7 million people working in the state now. That's the 8th month of growth in a row and is an all time record. More people are working in Pennsylvania, in raw numbers, than ever before. There are just under 700,000 people that work in manufacturing. That number is down almost a half a million from its peak ten plus years ago and it's still dropping, although at a slower rate. Four

years ago, we were losing 4,000 manufacturing jobs per month. We're now down to under 1,000 per month. It still is by far the number one contributor to our gross state product. In excess of \$60 billion a year. So, we've got an economy that, while it's diversifying and becoming more service dependent, still has a large industrial sector that we are determined to save. The Governor instructed me to figure out a strategy to do everything we can to use our existing resources. We had a summit with the IRCs and one of the best things that came about is the IRCs, pretty much on their own volition, came back to us and said we want to study in depth what's going on here. We want to do it region by region and we want to come back to you with a plan of action on how to deal with this. The IRCs came back with a compelling set of data and more importantly, a strategy based on that data, that essentially said the solution for manufacturing in Pennsylvania (I believe this applies nationwide), is not continued cost cutting as the primary driver to compete with low cost commodity manufacturing.

The key is innovating product, innovating process, innovating in our work force and creating protectable, unique, niche oriented, value-added people product and processes that can't be easily replicated by cheap overseas labor competition. The Governor's response to their proposal, probably much to the IRCs-surprise, was to increase their budget by 50 percent at a time when we were fighting for every dollar in our budget.

The IRCs have delivered by adding new technical assistance programs that go to the core of how we help our small and mid-size manufacturers innovate products, innovate processes and innovate our workforce.

We also used the data from that study to develop a statewide strategy that incorporated issues beyond what the IRCs were charged to deal with. First of all, we made a decision that we couldn't save, focus on, and invest in all of manufacturing in Pennsylvania.

There are some sectors that had higher growth potential and a higher survivability index than others. We identified those sectors where we had strength, where we had relative competitive advantage, and where there was growth potential. There are 16 of them. We are concentrating and pro-actively applying our resources and our energy on those 16 sectors on a region-by-region basis.

The second element of the strategy involves what I believe is Pennsylvania's greatest single asset: which is our college, university and health care systems. There are 260 institutions of higher learning in Pennsylvania. We graduate over 22,000 students a year with Science and Engineering degrees. The IRCs can help facilitate more by establishing

connections with our universities, more use of the workforce and of innovative ideas. We are doing a number of things to help drive research at both the university and the company level.

The next piece of the strategy is commercialization. We don't translate near enough of the billions of dollars of research that gets performed in this state into commercial products and services. We're determined that we're going to be able to turn that around and to provide both financing and other support to be able to do that. The IRCs play a key role in product strategy.

The other program that we've implemented is the

Keystone Innovation Zone Program (KIZ). It's a public/private partnership at a regional level involving multiple universities. The goal is to get the universities, the private sector, local government and the local economic development community together to make decisions on which sectors they're going to concentrate on and then to go about implementing programs that will retain students, start up new companies, and transfer more innovative ideas into the existing base.

The next element of the strategy is capital. The number one issue is lack of available capital for growth.

Number two was workforce, particularly an educated workforce. We have set about working with the private sector to make sure that capital was available if they need working capital to do new product development or beta testing of products or they need working capital to do overseas international expansion, equipment upgrades or construction projects.

Pennsylvania is the 6th largest manufacturing economy in America and the 17th largest in the

The next piece is Science and Engineering workforce. I think there is a key issue of orientation and incentive at the K through 12 level, particularly for women and minorities.

Beyond that, good jobs, high-paying jobs, available jobs aren't enough.

What's the solution? When I was in high school and I chose to go into Engineering in college, one of the reasons was Kennedy's speech about landing somebody on the moon. With which he created a national vision for something that almost everybody could associate with that drove the need for more Engineering and Science talent. I think we need to find something like that nationally and for example, alternate energy could be such a driving force. It's a national problem. It requires innovative technical solutions.

We also need to do more international recruiting of students. When students come to the United States, they spend money. A lot of them stay. Importing that talent in addition to educating our own is part of a strategy that can work. We're very determined to continue to work with all of you and work with our colleges and universities to make that happen.

Finally, part of the strategy is technical assistance. I've already talked about the IRCs. They're our go-to, on-the-ground organization in Pennsylvania for dealing with our small and mid-size manufacturing base. Tom Palinson is now officially the state's point of contact for a whole range of issues related to manufacturing and is our interface with the IRCs. We have a group called The Governor's Action Team which is a group of 25 people spread across the state whose job it is to be the single point of contact with companies when they're interested in expanding or relocating into the state. We've done over 700 projects in 3 1/2 years, 72 percent of them have been manufacturing companies. So we have



Eric Mittelstadt, Chief Executive Officer, National Council for Advanced Manufacturing

followed through and are applying our resources in ways that hadn't been done before and the numbers are beginning to reflect it.

So the final comment I want to make is that yes, manufacturing's under duress. Yes, America is under distress in terms of overseas competition. But we faced these things before. We faced them in automobiles. We faced them in semiconductors. We faced them in electronics and we've been able to turn those situations around. There's absolutely no reason why we can't do it here if we decide to act and if we act in a focused and collaborative way. So, thank you all very much for coming.



## ROUNDTABLE SESSIONS SUMMARY

### Roundtable # 1 - Engineering Deans Roundtable

#### Roundtable members:

**Chair/Moderator:** Dr. Eduardo Glandt,  
Dean, School of Engineering and Applied Science,  
University of Pennsylvania

Dr. Dave Brookstein, Dean, School of Engineering  
and Textiles, Philadelphia University

Dr. Ali Houshmand, Dean  
Goodwin School, Drexel University

Dr. H. Keith Moo-Young, Assistant Dean,  
Department Civil and Environmental Engineering,  
Villanova University

Walter Yakobosky, Dean, Occupational Studies  
Delaware County Community College

Engineers are a driving force in a strong economy. Without a vibrant engineering community, America's productivity, so essential to economic growth, would suffer. America's engineers are the most innovative in the world. Their ability to invent and create is what sets the United States apart. Without an innovative engineering workforce, America's future is less secure. Engineering schools graduated only 73,000 engineers last year, totaling less than 5 percent of all bachelor's degrees awarded. Our graduate schools are filled with foreign students who last year earned 58 percent of the engineering Ph.D. degrees awarded in this country. While we have relied heavily on these graduates to fill our technological needs, more and more of them are returning home after graduation. Part of our problem can be found in the homes of our K-12 students, where most students and parents have no idea what engineers do. To address this critical problem, action is being taken by the engineering community to improve K-12 student perceptions of engineering. Many engineering schools are sending professors into elementary, middle, and high schools to introduce students to the field. And engineering professional associations are publishing

magazines and creating web sites aimed at high school students, parents and teachers. If this nation is to meet its security needs and maintain its competitive edge, we must produce engineers in larger numbers than ever before. This is especially important when our economic competitors are graduating more than five times the number of engineers we do.

#### Questions discussed by Roundtable participants:

- What major trends are taking place in engineering education as a result of changing market needs in industry?
- How effectively is engineering education being tied in with technical education? With technology applications?
- What are engineering schools doing to collaborate more effectively with industry in dealing with technological change?
- How are engineering schools working with industry to support innovation and technology transfer?
- How well are students benefiting from changes being thrust on engineering schools and their programs by changing industry expectations and needs?

#### Overarching issues:

- Students entering engineering schools must come in as engineering generalists and specialize later as they obtain more information about specific engineering careers.
- Too many high school students forego majoring in engineering because they hear that "it is too hard."
- We need to increase and strengthen linkages between academia and industries to help students better understand what engineers must learn and what they do when they enter the world of work.

29% of all science and engineering degree holders in the labor force are 50 or over. Amongst science and engineering doctorate holders in the labor force, 44% are age 50

**Suggested Solutions:**

- Promote collaboration between engineering schools, K-12 systems, four-year colleges and universities, and business and industry to create regional partnerships to raise parent/student/educator/citizen awareness of engineering school requirements, sponsor engineering-related projects for K-16 students, and promote post-secondary engineering majors.

- Request the federal government to provide financial incentives to students registering as engineering majors at the post-secondary and graduate levels and fund engineering internships for high school counselors and teachers of math and science.
- Require all education entities to inform students of available incentives for post-secondary engineering majors.
- Urge engineering schools to assign faculty to increase awareness of engineering programs and careers for students, parents, teachers, counselors and administrators of middle and high schools.

**Roundtable # 1**

Overarching Issues	Suggested Solutions	Next Steps
Students entering engineering schools must come in as engineering generalists and specialize later as they obtain more information about specific engineering careers.	Better define engineering generalist and how that educational pathway would look and be developed.	Make this part of taking inventory.
Too many high school students forego majoring in engineering because they hear that “it is too hard.”	<ol style="list-style-type: none"> <li>1. Require all education entities to inform students of available incentives for post-secondary engineering majors.</li> <li>2. Request the federal government to provide financial incentives to students registering as engineering majors at the post-secondary and graduate levels, and fund engineering internships for high school counselors and teachers of math and science.</li> </ol>	Include this as one of several well-articulated policy issues supported by the region.
We need to increase and strengthen linkages between academia and industry to help students better understand what engineers must learn and what they do when they enter the world of work.	<ol style="list-style-type: none"> <li>1. Promote collaboration between engineering schools, K-12 systems, four-year colleges and universities, and business, industry, and government to create regional partnerships to raise parent/student/educator awareness of engineering school requirements; to sponsor engineering-related projects for K-16 students; and to promote post-secondary engineering majors.</li> <li>2. Urge engineering schools to assign faculty to increase awareness of engineering programs and careers for students, parents, teachers, counselors and administrators of middle and high schools.</li> </ol>	<p>A regional engineering deans group is being formed</p> <p>Key partners have agreed to create a Regional Compact to support a collaboratively developed Action Agenda.</p>

## Roundtable # 2 - Building Student Interest in STEM-related Careers

### Roundtable members:

**Chair/Moderator:** Carol Rieg, National Director  
National Engineers Week Future City Competition

Robert Dorn, Director of Northeast States,  
Project Lead the Way

Dr. Bryen Lorenz, Professor and Chairman,  
Department of Electrical Engineering  
Widener University

Ed McCallum, Director  
Corporate Relations and Strategic Alliances  
Society of Manufacturing Engineers

Lisa Nutter, President Philadelphia Academies Inc.

During the last two years, we have heard from many sources that this nation is falling behind other countries in attracting young people to pursue careers in science, technology, engineering and mathematics. Data from these and other studies show that American students rank well below the median in standard international math and science tests. To reverse this trend and increase the number of students majoring in STEM-related subject areas in U.S. colleges and universities, we must take steps to upgrade K-12 math and science teaching to foster higher student achievement in these areas, motivate and provide incentives for students to pursue STEM degrees and careers, and help students, parents and citizens better understand that STEM education is a high, national priority for creating higher paying jobs for Americans and for enhancing U.S. competitiveness in the global economy.

### Questions discussed by Roundtable participants:

- How early must students be introduced to STEM subjects as potential career choices?
- What can school systems do in the middle years (7th and 8th grades) to build student awareness of the vast variety of STEM career choices?
- How can a local industry-education collaborative

play a greater role in helping parents and students consider STEM-related career paths?

- How can an industry-education collaborative familiarize parents, students, and teachers about the many public incentives students can use to obtain post-secondary STEM degrees?
- What can STEM-focused companies do to provide students with first-hand experiences about the types of STEM-related jobs they need to fill over the next five to ten years?
- What more can state and federal government entities do to increase the number of STEM graduates and STEM job opportunities?

### Overarching issues:

- STEM-related pathways must be built and expanded throughout the region's K-12 education systems.
- Regional industries must invest in raising parental awareness of the value-added of STEM-related careers for their children and grandchildren.
- Policy makers at all levels must give greater attention to supporting and strengthening STEM education at the K-20 levels.

### Suggested solutions:

- Ask industry and government to provide scholarships to high-achieving high school graduates interested in STEM-related careers and internships for STEM majors at a post-secondary level.
- Require K-12 and post-secondary systems to build and certify pathways from high school through community colleges and/or four-year colleges and universities for students majoring in STEM courses.
- Utilize regional business-education collaboratives to help shape STEM-related curricula at the secondary level so it correlates with STEM-related career opportunities in the regional job market.
- Demand that Schools of Education improve and strengthen STEM-related under-graduate, graduate,

## Roundtable # 2

Overarching Issues	Suggested Solutions	Next Steps
STEM-related pathways must be built and expanded throughout the region's K-12 education systems.	Require K-12 and post-secondary systems to build and certify pathways from high school through community colleges and/or four-year colleges and universities for students majoring in STEM courses.	Create an inventory of regional 2+2+2 and 2+4 programs and disseminate through the partnership. Define program gaps and agree to work together to fill the gaps.
Regional businesses must invest in raising parental awareness of the importance of STEM-related careers and career opportunities for their children and grandchildren.	<ol style="list-style-type: none"> <li>1. Utilize regional business-education collaboratives to help shape STEM-related curricula at the secondary level so it correlates with STEM-related career, opportunities in the regional job market.</li> <li>2. Ask industry to provide scholarships to high-achieving high school graduates interested in STEM-related careers, and internships for STEM majors at the post-secondary level.</li> </ol>	<p>Create additional Industry Advisory Boards to engage in multiple ways with economic development organizations and schools.</p> <p>Take inventory of successful programs regionally and replicate them where possible.</p>
Policy makers at all levels must give greater attention to supporting and strengthening STEM education at the K-20 levels.	<ol style="list-style-type: none"> <li>1. Demand that Schools of Education improve and strengthen STEM-related undergraduate, graduate, and postgraduate programs to produce more and better STEM teachers.</li> <li>2. Ask government to provide scholarships to high-achieving high school graduates interested in STEM-related careers, and internships for STEM majors at the post-secondary level.</li> </ol>	<p>Invite the Deans of the Schools of Education to draft an Action Plan for creating the next generation of STEM instructors.</p> <p>Build on and augment programs such as Pennsylvania's Sci-Tech Scholars program.</p>

and post-graduate programs to produce more and better STEM teachers.

### **Roundtable # 3 - Integrating STEM-related Programs at the Secondary and Post-secondary Levels**

#### **Roundtable members:**

**Chair/Moderator:** Carol Fixman, Executive Director, Philadelphia Education Fund and Philadelphia Math & Science Coalition

Carol Adukaitis, Program Manager, PA State System of Higher Education and PA Department of Community & Economic Development

Michael Pearson, President, Union Packaging, LLC

Strengthening STEM education will increasingly depend on stakeholders' success in building and maintaining effective regional collaborations that bring together the very best ideas, programs and people from business, education, labor, government and the non-profit sector. Getting stakeholders to leave their silos so they can work in partnership is producing important changes in STEM education in many regions. Companies are investing in programs to increase K-20 student and teacher awareness of STEM subjects and the STEM talent needs of their industry sectors. Non-profit entities are using their own and government resources to develop and promote outreach programs that help K-20 students understand the nature of STEM, see how STEM knowledge is learned, and gain a better view of STEM-related jobs and careers in the nation's growth industries. And K-20 education systems and their teachers are joining with companies and non-profit groups in regional collaborations to implement STEM-focused programs that will help students and parents better understand the importance of STEM knowledge and STEM-related careers for themselves and the nation. By working together and integrating their efforts, collaborative STEM-based programs are making things happen for K-20 students, teachers and parents across the region.

By working together and integrating their efforts, collaborative STEM-based programs are making things happen for K-20 students, teachers and parents across

#### **Questions discussed by Roundtable participants:**

- What are some good examples of integrated STEM-related programs between high school and college?
- How can business-education collaborations stimulate the integration of STEM programs at the secondary and post-secondary levels to heighten student interest in STEM careers?
- What can be done to gain acceptance of integrated "fast pace" curricula in STEM education programs to permit students to move at their own speed from 9th grade through the 4th year at the post-secondary level?
- How can secondary education systems be persuaded to integrate their STEM curricula with post-secondary schools to permit students to move at a "fast pace" towards completion of STEM programs?
- How will enactment of "Innovation Math and Science Honors Scholarship Programs" as recommended by the House Innovation and Competitiveness Act increase student interest in STEM careers?
- What other steps can local and regional decision-makers take to reduce barriers to integration of STEM-related programs?

#### **Overarching issues:**

- Require STEM pipelines to have multiple entry and exit portals in courses that are both rigorous and built on high academic standards.
- Permit industry volunteers to work with middle school teachers to introduce students to STEM career choices and to review the content of STEM education courses used in middle and high schools.
- Introduce middle and high schools students to real-world STEM opportunities through proven national programs such as Project Lead the Way and Adventures in Technology.

**Suggested solutions:**

- Create a STEM magnet school in each major school district or urban county.
- Promote regional dual enrollment opportunities permitting high school students to earn credits for STEM courses taken at community colleges and four-year colleges and universities.
- Utilize regional business-education collaborative to support internships to keep STEM teachers current in their fields and provide school systems with industry STEM mentors.
- Develop a state supported "best practices" clearinghouse to share information with educators about model STEM programs and pedagogy, and prevent duplication of effort.

**Roundtable # 3**

Overarching Issues	Suggested Solutions	Next Steps
Require STEM pipelines to have multiple entry and exit portals in courses that are both rigorous and built on high academic standards.	<ol style="list-style-type: none"> <li>1. Create a STEM magnet school in each major school district or urban county.</li> <li>2. Promote regional dual enrollment opportunities permitting high school students to earn credits for STEM courses taken at community colleges and four-year colleges and universities.</li> </ol>	<p>Work with the Math/Science Partnership of Greater Philadelphia and the Philadelphia Math and Science Coalition to define how these might be done.</p> <p>Build on the work completed or in process under existing state and local programs.</p>
Permit industry volunteers to work with middle school teachers to introduce students to STEM career choices and to review the content of STEM education courses used in middle and high schools	Utilize regional business-education collaboratives to support internships to keep STEM teachers current in their fields and provide school systems with industry STEM mentors.	Support the build out of the regional “Internship in a Box” program developed by Innovation Philadelphia.
Introduce middle and high school students to real-world STEM opportunities through proven national programs such as Project Lead the Way and Adventures in Technology.	Develop a state supported “best practices” clearinghouse to share information with educators about model STEM programs and pedagogy, and prevent duplication of effort.	Articulate what a regional clearinghouse or inventory would look like, how it would be used, who would use it, and how it would be sustained.

## Roundtable # 4 - Developing STEM-related Professional Development Programs for Teachers

### Roundtable members

**Chair/Moderator:** F. Joseph Merlino, Principal Investigator, The Math/Science Partnership of Greater Philadelphia

Robert E. Baker, Jr., Secretary's Regional Representative, U.S. Department of Education

James Sturges, Director, Engineering Processes Lockheed Martin Corporation

Fundamental to improving student learning and achievement is the need for highly qualified teachers in every classroom. Research confirms that teachers are the single most important factor in raising student achievement. Teachers must have mastery of content and instructional methods to be effective educators and mentors. However, recent data published as part of the 2003 Trends in International Mathematics and Science Survey indicate that less than eight percent of elementary students are taught by teachers with a major or specialization in mathematics or science. The statistics improve somewhat at the 8th grade level where 48 % of students are taught by teachers who majored in mathematics and 15% by teachers who majored in science. But, the data clearly show that a significant majority of students are being taught math and science by teachers who lack significant training in the subjects they teach. Further investment beyond Teacher Quality State Grants is necessary to address the variety of challenges confronting local school districts - teacher preparation, higher qualifications for new teachers, recruitment and hiring, and high-quality professional development that increases content knowledge and ensures that students have access to teachers who can work with more rigorous curriculum.

### Questions discussed by Roundtable participants:

- How can regional partnerships stimulate the adoption of STEM-focused training and retraining programs for K-12 teachers programs to fill the current teacher skills and knowledge gaps in STEM and foreign language education?

- What must be done to create accelerated teacher certification programs for individuals with STEM and foreign language experience and skills?
- How effective is an Adjunct Teacher Corps likely to be in filling the short-term needs for "experienced" STEM teachers at the K-12 level?
- What must we do to refocus teacher training at the traditional teacher training institutions to bring about reform of long-established teacher training principles and curricula?
- How can sufficient public and/or private funding be raised to augment federal investments in STEM teacher training partnerships at institutions of higher education to improve math and science instruction at the elementary and secondary levels?

### Overarching issues:

- Too many local school systems operate without a coherent vision or focus on STEM teacher professional development needs.
- State support in PA for teacher professional development programs is declining rather than increasing.
- STEM teacher professional development programs should be designed to reflect the continuous changes taking place outside the classroom in science, technology, engineering and math.

### Suggested solutions:

- Increase the number of summer institutes sponsored by industry to introduce K-12 teachers to STEM in the workplace.
- Ask regional business-education collaboratives to provide industry members with increased opportunities to help shape and participate in regional STEM teacher professional development initiatives.
- Involve industry members of a regional collaborative in providing a real-world context to K-12 STEM curricula to better engage students' interest in STEM.
- Using the leverage of a regional collaborative, develop an Advanced Placement/International Baccalaureate (AP/IB) Program within the region's teacher training institutions and universities to train undergraduate and graduate students to be AP/IB teachers in math and science courses.

- Create a regional Adjunct Teacher Corps to encourage math and science professionals from industry to serve as adjunct middle school and high school STEM teachers.
- Request the state to set higher standards for STEM teachers and require more rigorous training of teacher candidates at the college and university levels.

## Roundtable # 4

Overarching Issues	Suggested Solutions	Next Steps
Too many local school systems operate without a coherent vision or focus on STEM teacher professional development needs.	<ol style="list-style-type: none"> <li>1. Involve industry members of a regional collaborative in providing a real-world context to STEM-based K-12 curricula to better engage and hold students' interest in STEM.</li> <li>2. Create a regional Adjunct Teacher Corps to encourage math and science professionals from industry to serve as adjunct middle and high school STEM teachers.</li> </ol>	Support the Math/Science Partnership of Greater Philadelphia and the Philadelphia Math & Science Coalition efforts to coordinate professional development for STEM teachers.
State support for local teacher professional development programs in PA is declining rather than increasing.	Request the state to set higher standards for STEM teacher education and require more rigorous training of teacher candidates at the college and university level.	Add this to a list of policy items to discuss with state departments of education.
STEM teacher professional development programs should be designed to reflect the continuous changes taking place outside the classroom in science, technology, engineering and mathematics.	<ol style="list-style-type: none"> <li>1. Increase the number of summer institutes sponsored by industry to introduce K-12 teachers to STEM in the workplace.</li> <li>2. Ask regional business-education collaboratives to provide industry members with greater opportunities to help shape and participate in regional STEM teacher professional development activities.</li> </ol>	<p>Inventory existing programs and develop new ones where needed. Aggregate demand at the school/instructor level and approach industry through IRCs, MEPs, Ben Franklins, and professional societies.</p> <p>Develop a technology-based learning strategy that will support, over time, the transformation of every STEM classroom in the region.</p>

## Roundtable # 5 - Integrating STEM into Incumbent Worker Education

### Roundtable members:

**Chair/Moderator:** Jennifer McNelly, Director, Business Relations Group, Employment and Training Administration, U.S. Department of Labor

Mary Beth DiVincenzo, Program Director, Chester County Economic Development Council

Robert Leber, Director, Education and Workforce Development, Northrop Grumman Corporation

Scott Sheely, Executive Director, Lancaster County Workforce Investment Board

Education, training, and retraining provide individuals with better career options, opportunities for promotion, and the ability to contribute to the U.S. innovation enterprise. Americans today look to community colleges and 4-year colleges and universities for the world-class educational opportunities that will provide them with the knowledge and skills they need to qualify for the increasingly technical jobs in U.S. companies. As change runs rampant through the U.S. job market, millions of incumbent workers must upgrade their skills and/or acquire new skills if they wish to remain employed. Access to STEM-related post-secondary education programs is essential if U.S. workers are to acquire the knowledge and skills they need to make efficient use of the cutting-edge technologies in the nation's growing high tech world. As the "baby boomer" retirements increase, incumbent workers must be encouraged to seek the newer and more technical skills that will help U.S. companies grow and compete in an ever-expanding global marketplace.

While the U.S. manufacturing sector has contracted sharply since the early 1980s, employment in high-skill manufacturing occupations has risen by an impressive 37 percent.

Federal Reserve Bank of New York; Volume 12, Number 2; February/March

### Questions discussed by Roundtable participants:

- Which education entities are incumbent workers likely to attend to take STEM-related courses?
- Where can incumbent workers find the funds and/or loans needed to pay for several years of STEM-related courses as part-time students in colleges and/or universities?
- How can full-time incumbent workers realistically pursue STEM-related bachelor and master degrees that require 30 or more hours of credits? What critical barriers are incumbent workers likely to face in acquiring higher education degrees?
- How can employers assist incumbent workers acquire STEM-related degrees that would make them better able to handle new technologies and to increase company productivity and competitiveness?
- How effective are federal employer-based training tax credits likely to be as an incentive to increase employer participation in STEM-related degree programs for incumbent workers?
- What can public/private collaborative do to encourage the region's employers, community colleges, 4-year colleges, universities, and unions to support the concept of life-long learning for incumbent workers?

### Overarching issues:

- A "common language" is needed for all stakeholders (e.g. Work Keys).
- The pipeline for workers extends from "K to Gray."
- Career pathways can be within an industry and across industries.
- The regional collaborative must build stronger links between career paths within education entities and job opportunities in the world of work.
- Training incentives must be offered to workers to keep them in the workforce pipeline.

### Suggested solutions:

- Pipelines must be tied to jobs that are immediately available and reflective of changing industry needs.
- Job opportunities must be communicated to workers in terms of required competencies and the available skills-upgrading in the education process.

- Industry-designed career ladders must provide multiple levels for entry and exit, and serve as a framework to implement performance training.
- Standards and certifications must be industry defined; certifications must be portable.

- The regional business-education collaborative must be industry-driven but in a non-threatening way.
- Training and education for incumbent workers must be accessible and affordable.

## Roundtable # 5

Overarching Issues	Suggested Solutions	Next Steps
A common stakeholder language is needed for integrating STEM into incumbent worker education.	Standards and certification must be industry-defined and understandable to all stakeholders.	Define the extent and dimensions of the issue with all stakeholders. Build on current work being done in the region.
The pipeline for workers extends from “K to Gray.”	<ol style="list-style-type: none"> <li>1. Pipelines must be tied to jobs that are immediately available and responsive to changing industry needs.</li> <li>2. Certifications must be portable across industries.</li> </ol>	<p>Create a systematic way to have incumbent worker training inform curriculum development and revision.</p> <p>Utilize industry-approved programming</p>
Career pathways can be within an industry and across industries.	<ol style="list-style-type: none"> <li>1. Job opportunities must be communicated to workers in terms of required competencies and available skills-upgrading.</li> <li>2. Industry-designed career ladders must provide multiple levels for entry and exit.</li> <li>3. Career ladders can serve as a framework to implement industry-designed performance standards.</li> </ol>	<p>Identify best practices through groups such as SHRM and ASTD.</p> <p>Articulate how career ladders and lattices would be utilized.</p>
Regional business-education collaboratives must build stronger links between career paths within education entities and job opportunities in the world of work.	Regional business-education collaboratives must be industry-drive, but in a non-threatening way.	Create a working group to develop a methodology for aligning educational and career pathways.
Training incentives must be offered to workers to keep them in the workforce pipeline.	Training and education must be accessible and affordable for incumbent workers.	Encourage private sector to offer generous tuition reimbursement benefits and professional development opportunities for associates at all levels.

## Roundtable # 6 - Sector Issues/Approaches to Deal with STEM Education

### Roundtable members:

**Chair/Moderator:** Dr. Winston Erevelles, Dean,  
School of Engineering, Mathematics & Science,  
Professor of Engineering, Robert Morris University

Carol Parssinen, Senior Vice President, The Franklin  
Institute

Steve Quinlan, Senior Program Officer, Society of  
Manufacturing Engineers Education Foundation

Emerging technologies and innovation within the U.S. public and private sectors will require American scientists, technologists, engineers, biologists, mathematicians, etc. to upgrade their knowledge and skills on a continuous basis so they can help their employers be productive and competitive in a constantly-changing global business environment. STEM-trained individuals must be prepared to pursue life-long learning during their working years to make sure they have the most up-to-date knowledge and skills their employers require. As many industries transform themselves into different entities to respond to the needs of the marketplace, regional industry-education collaboratives will have to provide the leadership and resources needed to change the way STEM education programs are designed and conducted in order to prepare K-20 students for 21st century careers.

### Questions discussed by Roundtable participants:

- How is STEM education being influenced or re-structured by emerging businesses undergoing transformation by technology and innovation?
- What is the impact on STEM education of emerging sectors such as aerospace, biotechnology, hydrogen-based fuels, geospatial technology, and nanotechnology?
- How will these new technologies impact on STEM education in K-12 schools where early student attitudes are shaped?

- What new incentives, if any, are needed to increase student interest in careers in these emerging sectors across the education spectrum from 6th grade to the Ph.D. level?
- How can public/private collaborations provide the leadership needed to transform STEM education and enable it to address student and industry needs in these new sectors?

### Overarching issues:

- New and emerging technologies require K-20 schools to update STEM-related curricula and teacher skills on a continuous basis to provide their graduates with the latest STEM knowledge and skills.
- New and emerging technologies require industry leaders and regional collaboratives to intensify their outreach to parents, students, teachers, counselors and administrators to increase interest in STEM-related courses and careers.
- Companies and regional collaboratives must increase the placement of state-of-the-art equipment and materials in K-12 STEM classes to give students access to real-world learning experiences.

### Suggested solutions:

- State departments of education must mandate that all middle and high school students take STEM classes to better understand the need for increasingly technical knowledge and skills in an ever-changing world.
- K-20 STEM teachers must have greater access to summer and short-term internships in regional companies to inform them of the changing STEM-related knowledge and skill requirements of industry.
- K-12 students must be provided increased contextual learning in STEM-related courses.
- Regional collaboratives must invite key company executives to serve on advisory groups shaping STEM-related education programs in K-12 school systems.
- Under-30 engineers, scientists and technologists must periodically visit middle and high schools to introduce students to the challenges of STEM-related careers and to serve as STEM mentors.

## Roundtable # 6

Overarching Issues	Suggested Solutions	Next Steps
<p>New and emerging technologies require K-20 schools to update STEM-related curricula and teacher skills on a continuous basis to provide their graduates with the latest STEM knowledge and skills.</p>	<ol style="list-style-type: none"> <li>1. State departments of education must mandate that all middle and high school students take STEM courses to better understand the need for increasingly technical knowledge and skills in an ever-changing world.</li> <li>2. K-20 STEM teachers must have greater access to summer and short-term internships in regional companies to be informed of the changing STEM-related knowledge and skill requirements of industry.</li> </ol>	<p>Ask Math/Science Partnership of Greater Philadelphia if superintendents would articulate this need and take the lead on discussions with state departments of education.</p> <p>Obtain financial resources to build on successful models such as the Emerging Science and Technology program at West Chester University.</p>
<p>New and emerging technologies require industry leaders and regional collaboratives to intensify their outreach to parents, students, teachers, counselors and administrators to increase interest in and familiarity with STEM-related courses and career paths.</p>	<ol style="list-style-type: none"> <li>1. Regional collaboratives must invite key company executives to serve on advisory groups shaping STEM-related education programs in K-12 school systems.</li> <li>2. Under-30 engineers, scientists, and technologists must periodically visit middle and high schools to introduce students to the challenges of STEM-related careers and to serve as STEM mentors.</li> </ol>	<p>Analyze current inventory for best practices and create a plan to adopt or replicate them.</p> <p>Create opportunities to increase existing programs, including internships, mentoring, and school-business partnerships.</p> <p>Increase volume of career awareness and development activity in the region.</p>
<p>Companies and regional collaboratives must increase the placement of state-of-the-art equipment and materials in K-12 STEM classes to give students access to real-world learning experiences on equipment and materials being used in industry.</p>	<p>K-12 students must be provided increased contextual learning experiences in STEM-related courses so they can see how STEM knowledge is applied in a real-world setting.</p>	<p>Define the needs of the 21st Century STEM classroom and utilize the latest in cognitive science to provide “best-in-class” STEM instruction.</p> <p>Put an “Innovation Lab” in every school.</p>

## Roundtable # 7 - STEM and Economic Development

### Roundtable members:

**Chair/Moderator:** Linda Fowler, Senior Analyst,  
NIST MEP, U.S. Department of Commerce

Dr. Paul Hallacher, Director, Research Program  
Development, Office of the Vice President for  
Research, The Pennsylvania State University

RoseAnn Rosenthal, President and CEO  
Ben Franklin Technology Partners of Southeastern  
Pennsylvania

For economic development programs to succeed in the 21st century, public and private entities interested in strengthening and expanding a region's economy must first learn how to "collaborate" in meeting the knowledge and skill needs of new or expanding employers. Key leaders of the entities that provide financing, labor market information, education, training, real estate expertise, and economic forecasting assistance must develop the innovative partnerships that enable them to channel their knowledge and resources towards the common goal of building a growing, knowledge-based regional economy and attracting high-growth companies.

Increasingly, the high-skill needs of new or expanding companies place a premium on the integration of STEM-related education into the preparation of new employees or the retraining of incumbent or dislocated workers. Regional collaborations must have the discretion to design innovative partnerships that include all of the region's key players including: the community colleges, 4-year colleges and universities, Workforce Investment Boards, financial and lending entities, trade and business associations, and local governments.

### Questions discussed by Roundtable participants:

- How can regional economic development leaders be sure they can deliver the right people with the right skills when they begin to "sell" their region to high-growth companies interested in moving new facilities into the area?
- What can regional colleges and universities do to assure economic development entities that they can meet the current and future STEM education and knowledge expectations of innovative companies interested in locating in the Tri-State area?
- How can public/private collaboratives provide the dynamic regional leadership needed to improve and re-design K-12 public school systems so they can be responsive to the STEM talent development needs of the region, especially for new and expanding companies?
- How can the region's governors better channel their state's resources to incentivize regional economic growth and job development to make the Tri-State companies more productive and able to compete in the global marketplace?
- Who will design and test the metrics that can periodically be used to measure performance of regional economic development initiatives? Who will design the benchmarks to track the short and long-term impact of economic development initiatives on the regional economy?

### Overarching issues:

- Many high school students (as well as their parents and school counselors) are not familiar with the level of job growth or the STEM skill needs of small “growth” companies in their region and consequently are unable to build these factors into their education and career planning.
- Communications between economic development stakeholders (including K-12 and higher education entities) and smaller “growth” companies is sporadic and therefore limits the amount of information that is available to educators in the region about the range of STEM-skills needed in many growth companies.
- Regional business-education collaboratives must undertake research projects that generate sufficient data about high-growth STEM-skill needs so that K-20 educators and key companies can develop STEM-focused education programs that provide qualified graduates for available job openings.

### Suggested solutions:

- Regional collaboratives must initiate and support research studies to determine the STEM-skill needs of regional companies, especially high-growth companies, and to help educators and industry leaders develop STEM-focused education programs that provide qualified graduates for available job openings.
- Collaborative members should conduct briefings at middle and high schools to familiarize parents, teachers and counselors with the long-term benefits of a STEM-related education in an ever-growing technical job market in the region.
- The number of summer internships should be increased for K-12 teachers and counselors in smaller high-growth companies needing workers with STEM-related skills for increasingly technical jobs.
- Regional collaboratives and member companies should conduct Junior Achievement-type programs to introduce middle school students to the World of STEM and sponsor regional competitions where young innovators design, build and demonstrate their products/inventions, guided by industry mentors.
- Increase university accommodation for full-time employees at smaller companies so they can pursue STEM-related courses on a part-time basis.

The US Bureau of Labor Statistics predicts that by the year 2010, there will be a skilled worker shortage of 8 million, increasing to approximately 14 million by 2020.

National Association of Manufacturers  
[www.nam.org/workforce](http://www.nam.org/workforce)

## Roundtable # 7

Overarching Issues	Suggested Solutions	Next Steps
<p>Many students, parents, teachers, counselors and administrators are not familiar with the level of job growth in their communities or with the STEM-skill needs of local industry, especially smaller, high-growth companies.</p> <p>Broad agreement that STEM education is an economic development imperative.</p>	<ol style="list-style-type: none"> <li>1. Regional collaboratives and member companies must conduct Junior Achievement-type programs to introduce middle school students to the world of STEM, and sponsor regional competitions where young innovators design, build and demonstrate their products/inventions, guided by industry mentors.</li> <li>2. Collaborative members should conduct briefings at middle and high schools to familiarize parents, teachers and counselors with the long-term benefits of a STEM-related education in an ever-growing technical job market in the region.</li> </ol>	<p>Take inventory of the many existing programs and make the information and opportunity available to wide public.</p> <p>Support the formation of a single body of educational research to inform regional investment decisions.</p> <p>Incorporate appropriate suggested solutions into the plans of school districts.</p> <p>Create a consistent, regional communications plan.</p>
<p>Communications between economic development stakeholders, educators, and private employers is sporadic, limiting the kind of information that is available about the range of STEM-skills needed in many high-growth companies.</p>	<p>The number of summer internships should be increased for K-12 teachers and counselors in smaller, high-growth companies needing workers with STEM-related skills for increasingly technical jobs.</p>	<p>This is one element or option among many. Region should agree to a goal of having the best regional body of STEM teachers that constantly innovate.</p>
<p>Industry, and especially high-growth companies, must have current information about the availability of potential workers who have the knowledge and skills they need to be productive and competitive.</p>	<ol style="list-style-type: none"> <li>1. Regional collaboratives must initiate and support research studies to determine the STEM-skill needs of regional companies, especially high-growth companies, and help educators and industry leaders develop STEM-focused education programs that provide qualified graduates for available job openings.</li> <li>2. Increase university accommodation for full-time employees at smaller companies so they can pursue STEM-related courses on a part-time basis.</li> </ol>	<p>Take inventory of the region's STEM Pipeline. Build on the Applied Engineering Technology project goal of having 10,000 students in that portion of the region's STEM education system.</p> <p>Work with institutions to create flexible programming for full-time workers.</p>

## STUDENT ROBOTIC DEMONSTRATIONS SUMMARY

### High-Tech Robots Help Demonstrate Importance of Education in Science, Technology, Engineering and Math at STEM Forum

Students from middle school through college demonstrated the robots, which they built themselves and which include prototypes of robots currently being used by the U.S. Navy and NASA. The demonstration included a six-legged robot, a Martian rover, robots built from LEGOS and a robotic arm similar to one that is used to repair the Hubble Space Telescope.

The students are participants in the DVIRC-supported Secondary Robotics Initiative, an educational program designed to expose Philadelphia-area children to science, technology, engineering and math and encourage today's generation of students to consider careers in those industries.

The demonstration was part of the Science, Technology, Engineering, and Math (STEM) Talent Development Forum, hosted by DVIRC and the National Council for Advanced Manufacturing (NACFAM).

“The Secondary Robotics Initiative shows young students how cool and interesting careers involved with science, technology, engineering and math can be,” said Mel Payne, DVIRC Project Director. “This demonstration along with the STEM conference highlights strategies to ensure that business and



Speaker: Michael McPhilmy, Vice President of Human Resource Development for Southco, Inc. From left to right: Christian Mazza, Dan Lipsman, Julian Sciano, Alex Baldowski, Reheem Manning.

industry have access to a workforce that is educated in science, technology, engineering and math which it needs to compete in the global marketplace.”

Michael McPhilmy, Vice President of Human Resource Development for Southco, Inc., joined DVIRC and the students for the demonstration. Southco, which manufactures hinges for Lamborghinis and other exotic cars, is based in Concordville, Pa.

“I can think of few things more important to stimulating business in the Delaware Valley and the country as a whole, than encouraging our children to strongly consider a technical track as they contemplate their career opportunities,” said



Speaker: Mel Payne, Program Director, DVIRC. Left to right: A Baldi Middle School, Kivonnah Patterson, Dan Lipsman, Michael Trang, Anna Stepchin, Christian Mazza; Overbrook High School, Reheem Manni, Shavar Miles

McPhilmly. “Conferences like this and programs such as the Secondary Robotics Initiative demonstrate a commitment not only to the business community, but to preparing young people for future success.”

The Secondary Robotics Initiative is the largest urban, research-based middle grades program in the country. The initiative is supported by the DVIRC’s Applied Engineering Technology program, which was created to address the need for qualified and well-educated talent to fill careers in advanced technology and manufacturing firms. The program links industry leaders with educators to develop technology education programs – such as the Secondary Robotics Initiative – throughout the region.

“The Secondary Robotics Initiative has turned out to be a stunningly-successful way to increase student participation in science and technology,” said Velda Morris, a Robotics Education Specialist in the School District of Philadelphia’s Office of College and Career Awareness. “This program prepares our students for the future and helps build the highly-skilled and technically-savvy workforce that corporations are searching for.”

## Secondary Robotics Initiative Demonstrators

### CCA BALDI MIDDLE SCHOOL

#### Robotics Advisors:

Jane White  
Gloria Tuckey

#### Robotics Students:

Christian Mazza, 14, Grade 8  
Anna Stepchin, 14, Grade 8  
Michael Trang, 14, Grade 8  
Dan Lipsman, 14, Grade 8  
Kivonnah Patterson, 14, Grade 8

Demonstration Description: Students directed a robot made from LEGOs through an Ocean Odyssey obstacle course. The students constructed the robot for the FIRST LEGO League competition, an international robotics competition developed in partnership by FIRST (For Inspiration and Recognition of Science and Technology) and the LEGO group.

This year's FIRST LEGO League competition required students to choose an ocean or sea activity or resource and trace its impact on the oceans' health, biodiversity, and productivity. Students were to learn what the experts and other groups are doing in this area, and identify a challenge they are facing.

They were then required to develop an innovative solution to help them improve the use of this resource or activity, while minimizing the negative impact on our oceans for present and future generations.

### ROBERTO CLEMENTE MIDDLE SCHOOL

**Robotics Advisors:** Evelyn Cruz, Julia Olmedo

#### Robotics students:

Emil Sauris, 13, Grade 8  
Malik Daniels, 12, Grade 8



Center Michael Pahides, Senior Vice President Economic Development and Education, DVIRC. From Left to Right: CCA Baldi Middle School: Christian Mazza, Anna Stepchin, Michael Trang, Dan Lipsman, Kivonnah Patterson

Emily Leon, 13, Grade 8  
Shavar Miles, 12, Grade 8

Demonstration Description: Students used a remotely operated vehicle called a Sea Perch that they built to retrieve items underwater. The Sea Perch program was developed by MIT in partnership with the U.S. Navy. The program introduces pre-college students to the wonders of underwater robotics.

Part of the Office of Naval Research's initiative, "Recruiting the Next Generation of Naval Architects," teaches students how to build an underwater robot (called a Sea Perch), how to build a propulsion system, how to develop a controller, and how to investigate ballast and buoyancy.

The endeavor is one funded by the Office of Naval Research as part of its National Naval Responsibility Initiative. The initiative focuses on bringing

academia, government and industry to work together to ensure that the talent needed to design the Navy's next generation of ships and submarines will be there when needed.

### **OVERBROOK HIGH SCHOOL**

**Robotics Advisor:** Vicki Baker

**Robotics student:**

Raheem Manning, 17, Grade 12

Demonstration Description: Manning demonstrated a robotic arm that he built as part of the Philadelphia BEST (Boosting Engineering Science and Technology) program. The arm is a prototype of the robotic arm NASA uses to repair the Hubble Space Telescope. The BEST program is designed to inspire and interest students in engineering, science, and technology through participation in exciting sports-like technology contests.

### **UNIVERSITY OF PENNSYLVANIA**

**Robotics Advisor:** Joel Weingarten

Demonstration Description: Students demonstrated a cockroach-like robot named RHex. RHex is a six legged robot, capable of achieving a wide variety of dynamically dextrous tasks, such as walking, running, leaping over obstacles, climbing stairs, with a single autonomous platform. The robot is helping scientists understand the mechanical and neurological basis of locomotion.

### **PENN STATE UNIVERSITY**

**Robotics Advisor:** David Spencer

**Robotics Students:**

Julian Sciano, Junior

Alex Baldowski, Sophomore

Demonstration Description: The Penn State Mars Society student chapter demonstrated a remote-controlled rover that they have designed and built in order to prototype concepts for NASA Mars rovers. The objective of their project is to develop a rover that can be controlled by a virtual reality glove system that is meant to be worn under an astronaut's heavy gloves. Currently the rover is run by infrared remote control and features a custom-built steel frame.

The overall goal of the Mars Society is to promote human exploration of Mars. The Penn State Mars Society student chapter functions with the help of student volunteers and sponsors such as the Pennsylvania Space Grant Consortium.



Students from Penn State University demonstrated a remote-controlled rover that they have designed and built in order to prototype concepts for NASA Mars Rover

From Left to Right: Julian Sciano, Junior; Alex Bal

APPENDIX A

Regional Compact for  
STEM Education Partners

Math / Science Partnership of Greater Philadelphia students effectively learn mathematics and science. Participating schools, school districts, and supporting part

The Math/Science Partnership of Greater Philadelphia (MSPGP) is funded by the National Science Foundation. The major goal of the MSPGP is to attract, strengthen and retain a highly qualified math and science workforce for the Greater Philadelphia.

Program Goals for this partnership are:  
1) to ensure that all students have access to, are prepared for, and are encouraged to participate and succeed in challenging and advanced mathematics and science courses;

2) to enhance the quality, quantity and diversity of the 6-12 mathematics and science teacher workforce; and  
3) to develop evidence-based outcomes that contribute to understanding how

- ners include:
  - Institutions of Higher Education
  - Arcadia University
  - Bryn Mawr College
  - Dea Crest College
  - Haverford College
  - LaSalle University
  - Lehigh Carbon Community College
  - Lincoln University
  - Moravian College
  - Muhlenberg College
  - North Hampton Community College
  - Pennsylvania State University
  - West Chester University
  - Widener University
- Bucks County, PA School Districts
- Bensalem Township
  - Bristol Township
  - Centennial
  - New Hope-Solebury
  - Palisades
  - Pennridge
  - Quakertown Community
- Camden County, NJ School Districts
- Berlin
  - Camden County Vocational
  - Cherry Hill Township

Collingswood Borough	Colonial
East Camden County Regional	Hatboro-Horsham
Gloucester Co. Inst. Of Technology	Norristown Area
Gloucester City	North Penn
Haddon Heights	Springfield Township
Haddon Township	
Lindenwold Borough	Other NJ and PA Schools
Pennsauken	MAST Charter
Riverton Borough	Northern Burlington County Regional
Winslow	Phillipsburg
Delaware County, PA School Districts	Supporting Partners
Haverford Township	Da Vinci Discovery Center
Radnor Township	Delaware Valley Industrial Resource Center
Ridley	The Math Forum
Rose Tree Media	Research for Better Schools
Southeast Delco	MagPi
Wallingford-Swarthmore	WHYY
William Penn	
Lancaster/Chester County, PA School Districts	The Philadelphia Math & Science Coalition
Lancaster City	
Octorara	The Coalition's initial focus is on developing highly qualified math and science teachers through partnerships among universities, corporations and schools. Among the Coalition's goals for Philadelphia public schools are: to attract university math and science students into secondary level teaching positions so that they will teach in Philadelphia after graduation, and to attract industry STEM professionals to math and science teaching in Philadelphia. Participating and supporting institutions and organizations include:
Lehigh Valley, PA School Districts	
Allentown City	
Bangor Area	
Bethlehem Area	
Easton Area	
Nazareth Area	
Northampton Area	
Saucon Valley	
Montgomery County, PA School Districts	
Cheltenham Township	
	Arkema
	AstraZeneca

Ben Franklin Technology Partners of Southeastern PA students enrolled in some of the following partner institutions:

Chemical Heritage Foundation	Universities
Community College of Philadelphia	Drexel University
Delaware Valley Grantmakers	The Pennsylvania State University
Delaware Valley Industrial Resource Center	Philadelphia University
Drexel University	Villanova University
E.I Dupont De Nemours & Company	West Chester University
Ford Motor Company	Widener University
Franklin Institute	
General Electric	Community Colleges
GlaxoSmithKline	Community College of Philadelphia
IBM Corporation	Delaware County Community College
Lockheed Martin Corporation	Montgomery County Community College
Philadelphia Federation of Teachers	High Schools
Quaker Chemical Corporation	School District of Philadelphia (6 high schools)
Rohm & Haas Company	Bok, Carver, Frankford, Martin Luther King, Swenson, University City
School District of Philadelphia	Bucks County Technical School
Temple University	Chester County Intermediate Unit
The Boeing Company	Coatesville Area High School
University of Pennsylvania	Delaware County Technical Schools
University of the Sciences in Philadelphia	Haverford High School
Philadelphia Education Fund	Norristown High School
	North Penn High School
DVIRC Applied Engineering Technology (AET) Project	Radnor High School
	Upper Darby High School

Funded in part by a U.S. DOL-ETA High Growth Job Training Grant, the AET project brings together education, government, businesses, economic development, and associations and other partnerships to create industry driven educational programs utilizing 2+2+2, 2+4, and dual enrollment models. The major AET project goal is to have 10,000 people enrolled in this portion of the region's STEM education system within 5 years. To date there are 1,500

& Training Administration

Regional Economic Development

Ben Franklin Technology Partners of  
Southeastern Pennsylvania  
Delaware Valley Industrial Resource  
Center

Associations & Partnerships

BEST Robotics  
National Council for Advanced  
Manufacturing  
National Engineers Week Future City  
Competition  
National Tooling & Machining Associ-  
ation  
Project Lead the Way  
Society of Manufacturing Engineers

Delaware County Community College  
Applied Engineering Technology  
Advisory Board

Association of Builders & Contractors  
Beaver Tool and Machine  
Bucks County Community College  
Center for Arts & Technology  
Brandywine  
Chester County Department of Commu-  
nity Development  
Chester County Intermediate Unit  
Collegiate Consortium for Workforce &  
Economic Development  
Community College of Philadelphia  
Delaware County Commerce Center  
Delaware County Intermediate Unit  
Delaware County Office of  
Employment & Training  
Delaware County Technical School  
Delaware Valley Industrial Resource  
Center  
DFT Inc

APPENDIX B  
STEM FORUM REGISTRANTS

<p>Ashok Agrawal Dean, Math, Science, Engineering &amp; Technology St. Louis Community College at Florissant Valley</p>	<p>Howard Berkof Program Associate ASME Joseph Bordogna Alfred Fittler Moore Professor of Engineering University of Pennsylvania</p>
<p>Fred Akl Dean, School of Engineering Widener University</p>	<p>Starite Boyce Vice President for Institutional Advancement Cheyney University of Pennsylvania</p>
<p>Brian Armstead Program Director Philadelphia Education Fund</p>	<p>Arnold Bradburd Warehouse RealEstate Associates</p>
<p>Gaston Arrendondo Multimedia Curriculum Developer Lab Volt</p>	<p>David Brookstein Dean, School of Engineering and Textiles Philadelphia University</p>
<p>Robert Baker Secretary's Regional Representative U.S. Department of Education</p>	<p>Nancy Campbell Senior Program Director Philadelphia Academies, Inc.</p>
<p>Ed Ball Curriculum Coordinator Montgomery County Public Schools</p>	<p>Anthony Campione MSPGP South Jersey Coordinator MSPGP</p>
<p>Arden Bement Director and Acting Director National Science Foundation NSF</p>	<p>Bernie Carrozza Director, AEG Programs</p>

Delaware County Community College	Cindy Dietz Manager, Community Relations Rockwell Collins
Mary Celenza Dean: Math, Science & Health Careers Community College of Philadelphia	Terry DiPiero Administrative Assistant DVIRC
Mun Choi Associate Dean, Head of Mech. Eng. Dept. Drexel University	Marybeth DiVincenzo Program Director Chester County Economic Development
Richard Clancy Mathematics Consultant MSPGP	John Dixon Project Specialist/Consultant DVIRC
Donna Cleland Asst. Director for Science MSPGP	Victor Donnay Bryn Mawr College/ MSPGP
Martha Cogdell Director Federal & State Government Relations Rockwell Collins	Robert Dorn Director of University Initiatives Project Lead the Way
John Conley Assistant Vice President Philadelphia Industrial Development Corporation	Justin Driscoll Managing Director Education Network Pittsburg Technology Council
Gary Cooper Superintendent of Schools Radnor Township School District	Kenoye Eke Vice President for Academic Affairs & Provost Cheyney University of Pennsylvania
Emily Stover DeRocco Assistant Secretary U.S. Department of Labor	Winston Erevelles Dean, School of Engineering Robert Morris University
Scott Dietz Manager, Education Initiatives Catalyst Connection	Joanne Ferroni Director of Outreach Drexel University
	Carol Fixman Executive Director Philadelphia Education Fund

Patrick Flanagan Vice President Learning Innovations Gateway Technical College	Eduardo Glandt Dean, School of Engineering & Applied Science University of Pennsylvania
Eric Flicker Chief Financial Officer & Treasurer Pennoni Associates, Inc.	Lawrence Green Director of Sponsored Programs Cheyney University of Pennsylvania
John Foster President/ CEO NOCTI & The Whitener Group, Inc.	Kimberly Green Executive Director National Assoc. of State Dir's of CareerTechEd
Linda Fowler Senior Analyst NIST/MEP	Helen Groft Director of Workforce Development Delaware Economic Development Office
Linda Fulford Lange Advisors Inc.	Paul Hallacher Director , Research Program Develop ment Penn State University
Walter Fullam Director of Continuing Education Penn State Berks	Bernadine Hawes Board Chair DVIRC
Tom Gannon Manufacturing Specialist AFL-CIO Working for America Institute	John Henry Program Development Consultant Educational Information & Resource Center
Don Garbinski Senior Media Specialist DVIRC	Liza Herzog Director of Research Philadelphia Education Fund
Victoria Gehrt Superintendent of Schools Bensalem Township School District	Tom Hobson Senior Mgr. Goverment Affairs Rockwell Collins

Ambra Hook Director of Science School District Of Philadelphia	Edwin Koc Director, Research & Legislative Affairs Midatlantic Employer's Association
Jane Horwitz Associate Director Penn Science Teacher Institute	Karen Kohut Curriculum Development Manager Lab Volt
Joseph Houldin CEO DVIRC Ali Houshmand Engineering Dean, Goodwin School	Stanley Komacek Chair & Professor, California University of PA Applied Engineering & Technology
Kadian Howell-Clark Assistant Professor of Math Education	Rainer Kunau Canadian Consulate General
Jen DiQuattro Workforce Development Coordinator PA Dept. of Community & Economic Dev.	Wade Lange Founder Lange Advisors Inc.
Lisa Jennings Prg. Mgr. for Diversity & Pre-College Outreach American Society of Civil Engineers (ASCE)	Adina Laver Leadership Development Specialist MSPGP Tim Lawrence Executive Director SkillsUSA
Oskar Kalinowski Media Specialist Assistant DVIRC	Robert Leber Director, Education & Workforce Dev. Northop Grumman Corporation
Terri Kaufman Deputy Director PA WIB	Sandy Loewe Assistant Director Educational Information & Resource Center
Roger Kilmer Director, MEP NIST	James Logan
Edgar Knights Mathematics Specialist MSPGP	

Project Specialist/Consultant DVIRC	ences La Salle University
Nadline Lomakin Director of Programs Life Science Career Alliance	Jennifer McNelly Director of Business Relations U.S. Department of Labor
Frederick Loomis Director, Center for Continuing Professional Studies Arcadia University	Joseph Merlino Principal Investigator/ Project Director MSPGP
Bryen Lorenz Professor & Chairman, Electrical Engineering Widener University	Eric Mittelstadt Chief Executive Officer NACFAM
Thomas MacNamara Vice President, Human Resources Puresyn, Inc.	Keith Moo-Young Acting Dean Villanova University Melissa Murray Government Relations Representative ASME
Claire Marrasso Manager, Policy Development Select Greater Philadelphia	Lisa Nutter President Philadelphia Academies, Inc.
Edward McCallum Director, Corporate Relations & Strategic Alliance Society of Manufacturing Engineers	William Oppelt Business Consultant MSPGP
Karla McJunkin Project Specialist/Consultant DVIRC	Jane Owens Senior Director of Continuing Education Penn State Abington
McKinney Consultant Philadelphia Education Fund	LeeSa Page NACFAM
Margaret McManus Associate Dean, School of Arts & Sci	Michael Pahides Senior Vice President Economic-Devel

opment and Education, DVIRC	Cari Reilly Event Coordinator DVIRC
Jerry Parker President Delaware County Community College	Carol Rieg National Director Nat'l Eng. Week "Future City Competi
Jennifer Parsons Prime & Outreach Program Specialist Robert Morris University	tion"
Carol Parssinen Senior Vice President Franklin Institute	Jim Ringo Product Development Manager Lab Volt
Mel Payne Program Director DVIRC	John Romanski SME - Chapter 15
Michael Pearson President Union Packaging, LLC	Leonard Rosenfeld Chairman, Advisory Council PA Academy of Science
Charles Pizzi President Tasty Baking Company	RoseAnn Rosenthal President Ben Franklin Technology Partners-- SEPA
Deborah Pomeroy CO-PI Math Science Partnership of Greater Phila.	Rodney Sandmeyer Executive Vice President Sandmeyer Steel Company
Jerome Potash Director QEI	George Scamby Sr. Manufacturing Engineer Boeing
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## APPENDIX C

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## APPENDIX D

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