STEM: What is it and how do I help

TASC Luncheon
October 19, 2011

Christopher Poulos
Science Applications International Corporation

STEM Compenents Defined

- **Science** – the ***study*** of the physical world and its manifestations, especially through systematic observation and experiments.
- **Technology** – the application of scientific and engineering knowledge to achieve a ***practical result***.
- **Engineering** – the creation or development of new devices and objects that are of ***importance or value*** to humans and society.
- **Mathematics** – a branch of pure science or philosophy (logic) that in its ***applied*** state can be used to help make quantitative analysis and predictions for science, technology, and engineering.

Innovation – Creation of new ***value***

Slide from Jim Batterson
Preparing VA's Students…
Sept11

THEORY

SKILL COMPONENTS

HANDS-ON

Theoretical Physics ⟷ Experimental Physics

Mathematician	Scientist	Engineer	Engineer Technologist*	Trades
Discover languages to quantitatively describe existing world	*Discover & describe existing world*	*Design & build new systems*	*Fabricate & operate new systems*	*Build or repair existing systems/components*
Algebraist Geometer Topologist Statistician	Physicist Chemist Biologist Research MD Astronomer Geologist	Aerospace Automotive Chemical Electronics Computer Civil Model & Simulation Research Surgeon	Wind Tunnel Aircraft Maintenance Airframe/Powerplant Particle Detectors Integrated Circuits	**Traditional** Welding HVAC Electricity Plumbing Electronics Manufacturing (Surgeon 19th C.) **21st Century** A+ Comp Repair Comp Network Admin CISCO Network ORACLE Internet CAD Model & Simulation
4-yr College (+)	4-yr College (+)	4-yr College (+)	2-yr college/OJT	HS with National Certifications
Traditional Academic		Current K-12 "Gap"		CTE

Jimbatterson@live.com – May 2007

* Sometimes "Instrument Maker"

STEM – Example

Need for National Response to Sputnik/Cold War/Missile Gap

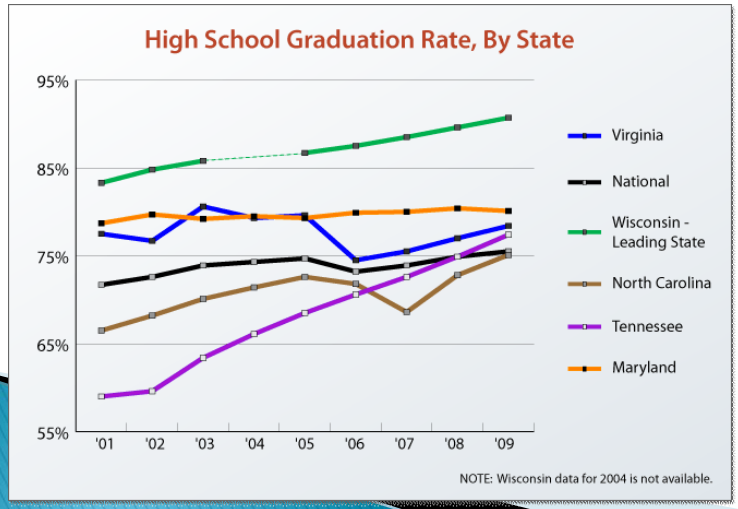
Carried out by:

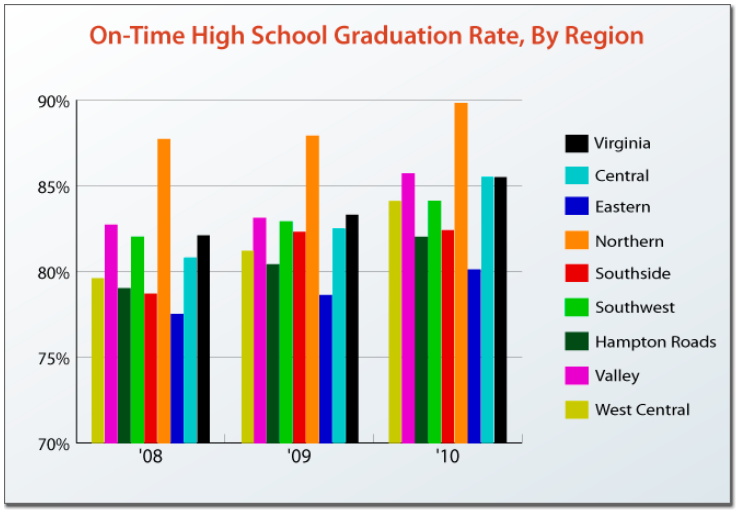
Engineers & many other professions & skills	**Innovation** – Humans to the Moon and Safely Return
Engineers, Technicians & Scientists	**Technology** – Rockets, Protective Clothing, Computers
Scientists & Engineers	**Science** – Newton's Laws of Motion/Gravitation, Chemistry
Mathematicians	**Mathematics** – Algebra, Geometry, Trigonometry, Calculus

Slide from Jim Batterson
Preparing VA's Students…
Sept11

The Challenge We Face

- The nation is expected to face a severe shortfall of professionals in the areas of science, technology, engineering and mathematics (STEM).
  - A large fraction of such workers will be eligible to retire soon
  - The pipeline of (US) students is falling short of the anticipated need
    - Half a century after the Space Race, American students are now ranked 22nd and 31st among their peers throughout the world in science and math, respectively
  - This problem threatens US prosperity, which over the last 50 years has been driven by technological advances. It is expected to affect the Aerospace and Defense industry – and thus, companies like ours
    - While the number of degrees awarded in the STEM fields has increased modestly over the past five years, only 15.6 percent of bachelor's degrees were awarded in these fields, and the overall share of degrees awarded in STEM fields actually shrank during this period.





The Challenge We Face

- A large number of activities and initiatives examine and/or address this problem. Examples:
  - Educate to Innovate; President Obama
  - America COMPETES Act (federal funding to support R&D, STEM education, innovation infrastructure)
  - ITEST, National Science Foundation
  - National Math + Science Initiative (public-private partnership)
  - NDIA Division, “Science, Technology, Engineering and Mathematics (STEM) Workforce”
  - National Academies study on “Capitalizing on the Diversity of the Science and Engineering Workforce in Industry”

Answering the Call – National Science Foundation ITEST Program

Example

- Addressing such questions as: What does it take to effectively interest and prepare students to participate in the science, technology, engineering, and mathematics (STEM) workforce of the future? What are the knowledge, skills, and dispositions that students need in order to participate productively in the changing STEM workforce and be innovators, particularly in STEM-related networked computing and information and communication technology (ICT) areas? How do they acquire them? How can the Nation's burgeoning cyber infrastructure be harnessed as a tool for STEM learning in classrooms and informal learning environments? What will ensure that the nation has the capacity it needs to participate in transformative, innovative STEM advances? How can we assess and predict inclination to participate in the STEM fields and how can we measure and study impact of various models to encourage that participation? Types of projects funded:
  - Research projects enrich the understanding of issues related to enlarging the STEM workforce.
  - Strategies projects design, implement, and evaluate models for classroom, after-school, summer, virtual, and/or year-round learning experiences for students and/or teachers.
  - Scale-up projects implement and test models to prepare students for information technology or the STEM workforce of the future in a large-scale setting such as at state or national level.
  - Conferences and Workshops target STEM educators (from both the formal and informal education communities), educational researchers, and evaluators.

STEM in the Commonwealth

- In the summer of 2007 and 2011, under the Virginia Secretary of Education, panels of practicing scientists & engineers conducted a gap-analysis of Virginia's physics & chemistry Standards of Learning (SOL) and engineering program to help inform the State Board of Education's 2010 science SOL review.

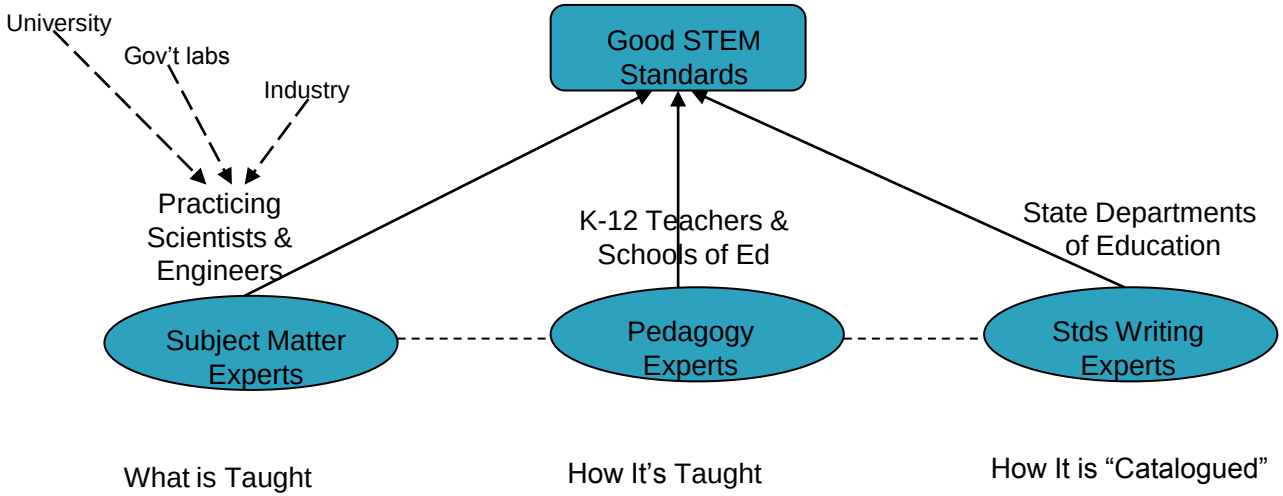
Preparing Students for the 21st Century STEM

- Panels of broadly selected practicing engineers and scientists met in facilitated two-day workshops
- Addressed the question of what science a competent Virginia citizen needs to know for the 21st Century
- Called for major changes to current content philosophy in chemistry & physics (current content is mid-20th C.)
  - 20% laboratory integrated and assessed
  - Contemporary & emerging applications must be taught & integrated
  - Organic chemistry must be reinstated
  - Move to a core/elective approach
  - DOE support open-source wiki for timely development of content
- Engineering design process learned by all students and pre-engineering high school program available to all students in VA (Engineering is NOT currently institutionalized throughout K-12 in the Commonwealth).

Slide from Jim Batterson
Preparing VA's Students…
Sept11

Summary of Study Findings

- While Virginia's SOL are clearly written and panels did not find another state whose SOL could be simply imitated - -
  - VA science (physics & chemistry) content are severely dated (early 1960's)
  - VA physics content is too broad causing shallow coverage
  - Engineering is neither required of nor generally available to all of Virginia's children
  - Virginia does not take advantage of 21st Century technology such as open source software (wiki) to develop timely curriculum content



Slide from Jim Batterson
Preparing VA's Students…
Sept11

Panel Recommendations

- Excellent Progress made on science SOL in 2010 state board actions
  - But consider strategic recommendations (e.g. ARISE)
  - Consider a Governor-appointed "STEM Subject Matter Expert Advisory Board" to provide annual report on state of K-12 STEM education in VA (essentially institutionalizes the 2007 panels)
- Innovation is the child of engineering
- Engineering not institutionalized in VA
  - No engineering endorsement; engineering teachers have "technology education" endorsement
  - Engineering not available to most students in VA
  - Turn-key programs are available K-12
- Recommendations
  - Develop "engineer" endorsement for high school engineering teachers (ABTEL) (licensing equivalent to SJ308)
  - Require VA Children's Engineering or equivalent in K-5 (pedagogy & 21st century workplace skills)
  - Make PLTW or equivalent available to ALL HS students

STEM Pipeline: Opportunities for Action

Scope of Impact:	Examples of Support:
Nation-wide	Support national organizations (teaching standards boards, professional organizations, SWE/NSBE/SHPE/etc, Girl Scouts/4-H/etc). Support curriculum development. Sponsor national ad campaigns. Create national-release videos and documentaries. Develop and host on-line games. Sponsor national-level challenges, “finals” of competitions.
State-wide	Support state initiatives (state STEM legislation, state-level competitions, etc).
Community-wide	Sponsor local science fair. Organize local competition, e.g. one that feeds state- or national-level challenge.
School-wide	Sponsor STEM-focused Career Day. Establish or support multi-grade design challenges. Donate STEM-related equipment. Assist with curriculum insertion.
Class/team	Support National Engineers Week. Send employees into classrooms (e.g. incentive volunteering). Sponsor class projects. Invite students to tour industrial facility.
Individual teacher	Support professional development programs (Space Camp, PLTW training). Bring teachers into industry for sabbaticals. Award teacher prizes.
Individual student	Award scholarships, fellowships, internships. Award individual student achievement prizes.

Technology in Hampton Roads

HAMPTON ROADS
TECHNOLOGY COUNCIL
Defense & Homeland Security Consortium

OLD DOMINION UNIVERSITY
BUSINESS GATEWAY

Local STEM activities

- For Inspiration and Recognition of Science and Technology (FIRST)
  - FIRST Robotics Competition for high-school students
    - http://www.roccobotics.com/gallery
  - FIRST Tech Challenge for high-school students
  - FIRST LEGO League for 9 to 14 year-olds
  - Junior FIRST LEGO League for 6 to 9 year-olds
  - FIRST Place for ages 6 to adult
- Project Lead the Way (PLTW)
- NDIA – STEM Division
- STEAM – Science, Technology, Engineering and Applied Math – academy in Hampton Roads
- Virginia Childrens Engineering Council
- Tidewater Science & Engineering Fair
- Individual Corporate Efforts
- …and more…

TIDEWATER SCIENCE FAIR

Virginia PLTW PROJECT LEAD THE WAY

A Call for Action

- …but there are many more activities
- This is our challenge – Industry must lead the way
- Two tangible ways
  - Participation – Corporate and individual to help lead and coordinate
  - Resources – Sponsors