Mechatronics Outreach @ Poly

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with

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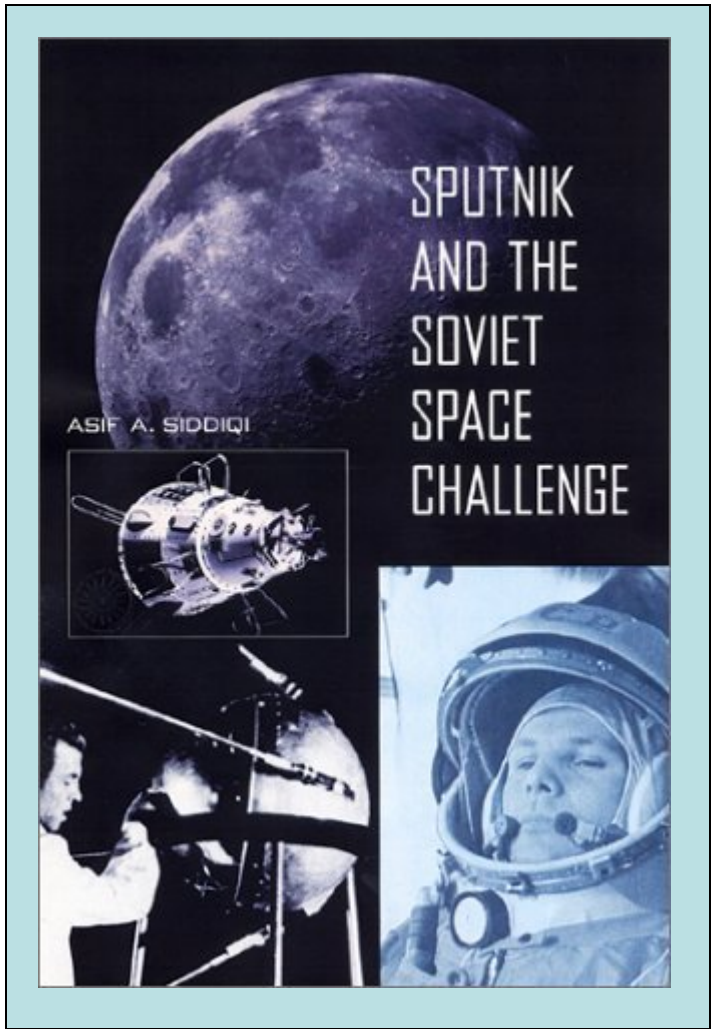
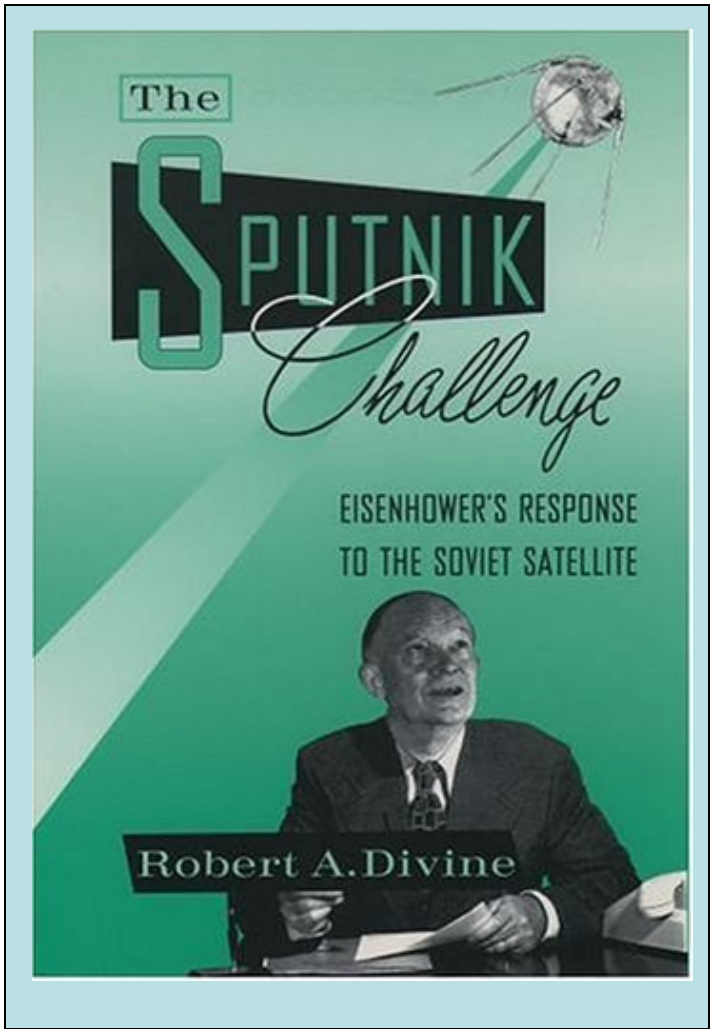
A Quick History Lesson

- October 4 1957: Soviets launched the world's first artificial satellite Sputnik I
- November 3, 1957: Soviets flaunt their power again by launching Sputnik II





Sputnik: The Aftermath

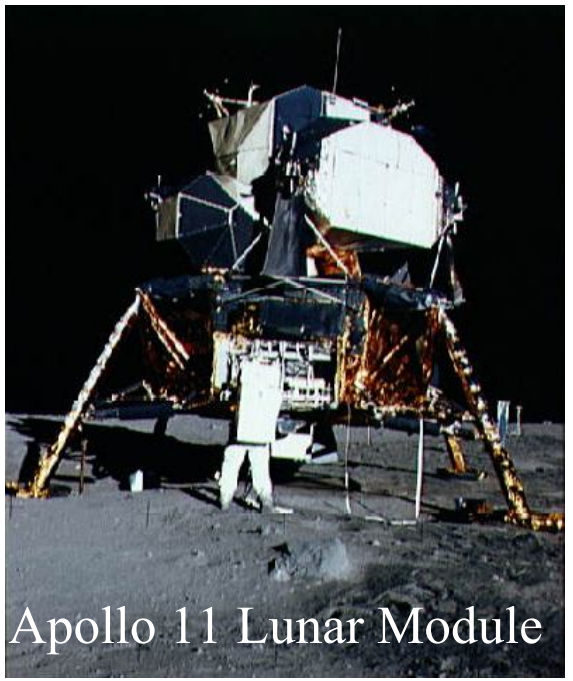
- Fundamental shift in the Cold War strategic balance
- Existential worries and confidence crisis
  - Hysterical fear of long-range Soviet missiles among the American public
  - Vigorous national debate exposed perilous weaknesses in American education, science, and national security
- Radio editorial "Thank You, Mr. Sputnik" by Gabriel Heatter of Mutual Broadcasting System in January 1958, hours after Sputnik I fell from orbit
  - "You gave us a shock which hit many people as hard as Pearl Harbor. You hit our pride a frightful blow."

Sputnik: The American Response

- Expansion of missile and reconnaissance-satellite programs
- Creation of a civilian space agency NASA
- Creation of the Advanced Research Projects Agency (predecessor of DARPA) within the Department of Defense
- Increase in federal aid to education
- Darwin's 1859 theory of evolution, which had been kept out of many classrooms until 1957, finally appeared in high school biology texts

American Response: Race to the Moon

- President Kennedy created the Apollo program in 1961 and challenged the U.S.A. to put a man on the moon before the turn of the decade
  - o Decade long race to moon
  - o Student enrollments surged in college-level science, technology, engineering, and math (STEM) programs
  - o Societal benefits: microelectronics, microcomputer, inertial guidance system, etc.



Apollo 11 Lunar Module

Astronaut Aldrin & U.S. flag on the Moon

The New Sputniks

- Global problems
  - Terrorism
  - Poverty → civic and social unrest
  - Public health, communicable disease (Avian flu)
  - Global warming → environment
  - Energy crisis
- Outsourcing of American service sector operations
- Increasing import of services and manufactured goods → growing trade deficits
- Perennial disinterest in STEM disciplines among students threatens the American leadership in scientific discovery and technical innovation (Innovation Economy/Knowledge Economy)
- Newspaper editorials, business/government advisory groups, and industry captains point to an urgent need to develop a strong and technologically trained workforce to ensure the American leadership in scientific discovery and technological innovation

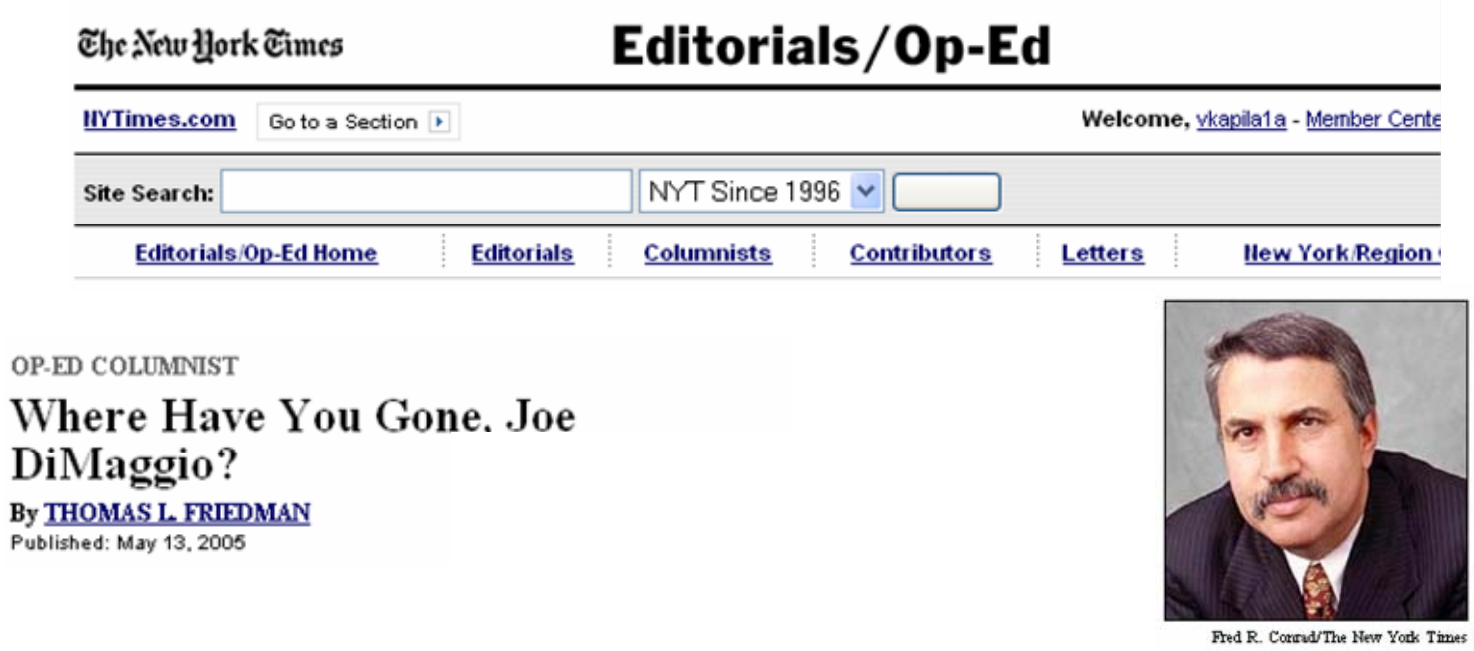
BILL & MELINDA GATES foundation Home > Newsroom > Speeches & Commentary > Speeches by Bill Gates

2.26.2005

National Education Summit on High Schools

Prepared remarks by Bill Gates, Co-founder

- America's high schools are **obsolete**.
- By obsolete, I mean that our high schools – even when they're working exactly as designed – cannot teach our kids what they need to know today.
- Training the workforce of tomorrow with the high schools of today is like trying to teach kids about today's computers on a 50-year-old mainframe. It's the wrong tool for the times.
- Our high schools were designed fifty years ago to meet the needs of another age. Until we design them to meet the needs of the 21st century, we will keep limiting – even ruining – the lives of millions of Americans every year.



The New York Times

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OP-ED COLUMNIST

Where Have You Gone, Joe DiMaggio?

By THOMAS L. FRIEDMAN

Published: May 13, 2005

Fred R. Conrad/The New York Times

- Indiana University High School Survey of Student Engagement, covering 90,000 high school students in 26 states:
  - **18% of college-track seniors did not take a math course in their last year in high school**
  - **more than a fifth (22%) of first-year college students require remediation in math**
- Professor Martha McCarthy, head of study told: "Our fear is that when you talk to employers out there, they say they are not getting the skills they need," in part because "the colleges are not getting students with the skills they need."

LOSING THE COMPETITIVE ADVANTAGE?

THE CHALLENGE FOR SCIENCE AND TECHNOLOGY IN THE UNITED STATES

FEBRUARY 2005

AeA

Advancing the Business of Technology®

Access to Investors
State, Federal & International Lobbying
Insurance Services • Government Procurement
Business Networking • Foreign Market Access
Select Business Services • Executive Education

LOSING THE COMPETITIVE ADVANTAGE?

THE CHALLENGE FOR SCIENCE AND TECHNOLOGY IN THE UNITED STATES

The dominance of the U.S. is already over. What is emerging is a world economy of blocs represented by NAFTA, the European Union, and ASEAN. There's no one center in this world economy. India is becoming a powerhouse very fast. The medical school in New Delhi is now perhaps the best in the world. And the technical graduates of the Institute of Technology in Bangalore are as good as any in the world. Also, India has 150 million people for whom English is their main language. So India is indeed becoming a knowledge center.

Peter Drucker
Fortune Interview, January 12, 2004[1]

The great benefits of globalization will accrue to countries and groups that can access and adopt new technologies . . . Those countries that pursue [policies that support the application of new technologies] could leapfrog stages of development, skipping over phases that other high-tech leaders such as the United States and Europe had to traverse in order to advance.

CIA's National Intelligence Council
Mapping the Global Future[2]

America needs to recognize that future innovation is not predetermined to occur in the United States. Even if we were doing everything right, we still face unprecedented competition from abroad.

AeA
Losing the Competitive Advantage?

INNOVATEAMERICA

December 2004

NATIONAL INNOVATION INITIATIVE REPORT
thriving in a world of challenge and change

Council on Competitiveness

Recommendations: Talent, Investment, Infrastructure

Talent

Build a **National Innovation Education Strategy** for a diverse, innovative and technically-trained workforce

- Establish tax-deductible private-sector "Invest in the Future" scholarships for American S&E undergraduates
- Empower young American innovators by creating 5,000 new portable graduate fellowships funded by federal R&D agencies
- Expand university-based Professional Science Masters and traineeships to all state university systems
- Reform immigration to attract the best and brightest S&E students from around the world and provide work permits to foreign S&E graduates of U.S. institutions

Catalyze the **Next Generation of American Innovators**

- Stimulate creative thinking and innovation skills through problem-based learning in K-12, community colleges and universities
- Create innovation learning opportunities for students to bridge the gap between research and application
- Establish innovation curricula for entrepreneurs and small business managers

Empower **Workers to Succeed in the Global Economy**

- Stimulate workforce flexibility and skills through lifelong learning opportunities
- Accelerate portability of healthcare and pension benefits
- Align federal and state skills needs more tightly to training resources
- Expand assistance to those dislocated by technology and trade

The Second Installment of the ITEA/Gallup Poll and What It Reveals as to How Americans Think About Technology

A Report of the Second Survey Conducted by the Gallup Organization for the International Technology Education Association

The American public is virtually unanimous in regarding the development of technological literacy as an important goal for people at all levels.

Just your opinion, how important is it for people at all levels to develop some ability to understand and use technology? Would you say it is:

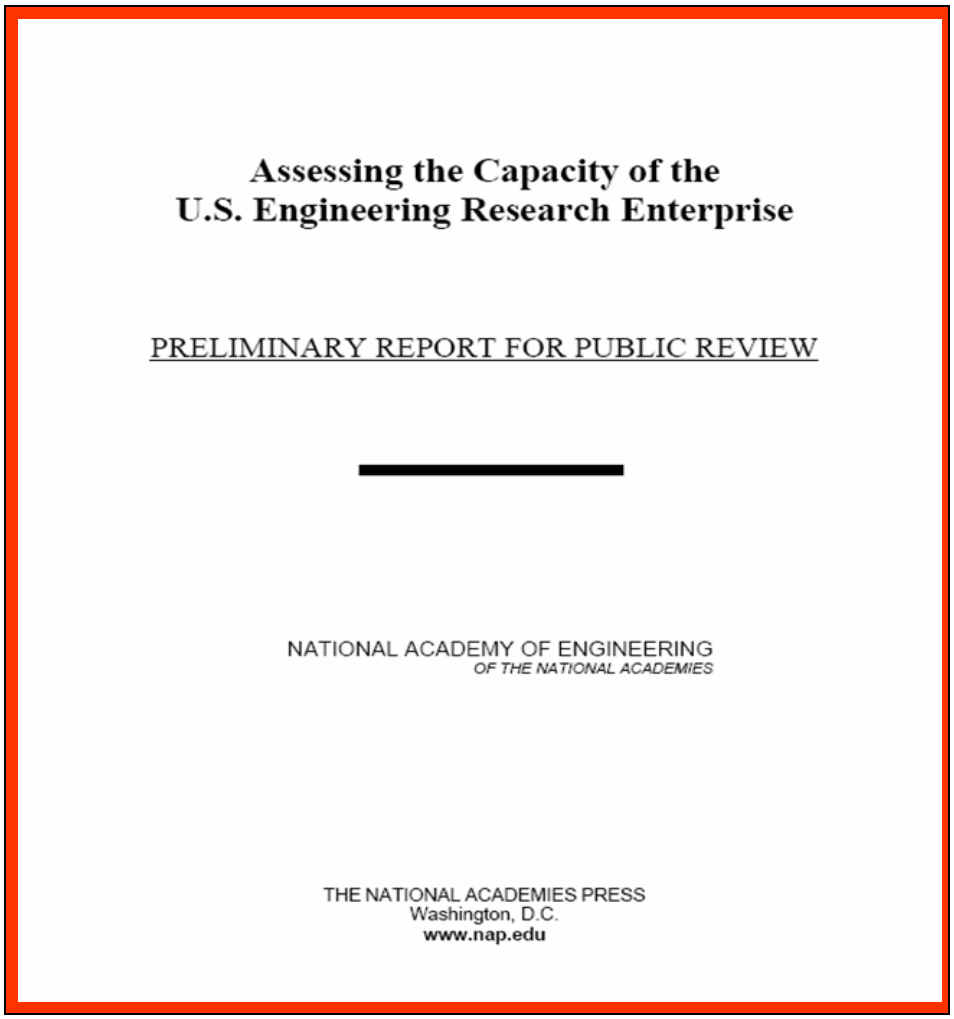
Importance	% Selecting 2004	2001
Very important	74	76
Somewhat important	24	23
Not very important	—	1
Not at all important	1	—
Don't know/refused	1	—

There is near total consensus in the public sampled that schools should include the study of technology in the curriculum.

Using a broad definition of technology as "modifying our natural world to meet human needs," do you believe the study of technology should or should not be included in the school curriculum?

Choice	% Selecting 2004	2001
Yes, should be included	98	97
No, should not be included	2	3
Don't know/refused	—	—

Note: In response to a follow-up question in 2001, 63% of those saying it should be included chose integration into other subjects in lieu of being taught as a separate subject. Of those choosing "a separate subject," 51% said the offering should be required, while 49% said it should be optional.



Recommendation 3. State and federal governments, academic institutions, accreditation bodies, and the private sector should take steps to cultivate U.S. student interest in, and aptitude for, careers in engineering, and in engineering research in particular. These steps should include providing more funding for graduate fellowships and traineeships and faculty development, as well as supporting efforts to improve K–12 math and science education to prepare high school students for careers in science and engineering.

Today's Students

- Lack interest in science and math due to:
  - Uninspiring lab experiments
  - Lack of connection to real life applications
- Attracted to new gadgets
  - iPod
  - Video games
  - Cell phones

Science and Mechatronics Aided Research for Teachers (SMART): A Research Experience for Teachers Program

- Introduce multidisciplinary field of mechatronics to teachers:

Training: Anshuman presenting the automated conductivity experiment to teachers.

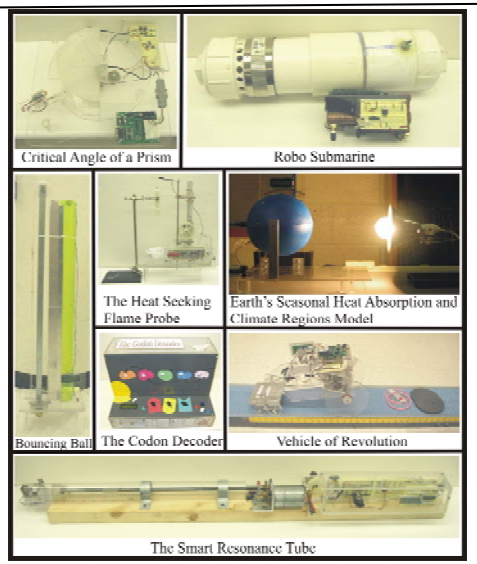
Mentoring: Ilya helps SMART weather balloon team test their experiment.

Research: Ed and Dvora work on a hands-on structured project.

- 4-week RET workshop
- First 2-weeks: teachers learn about sensors, actuators, electro-mechanical components, and microcontrollers
- Last 2-weeks: teachers develop mechatronics-aided science projects to experience the design, model, analyze, refine, prototype, and validate cycle arising in real-world mechatronics system development.
- Teachers integrate project-based learning:

Amanda and Ram with Quantum Leap experiment

- PI, over a dozen Poly students, and 38 NYC metropolitan area teachers since 2003 participated in this project.
- The teachers are being empowered to reinforce STEM training and educational experience of a diverse student body from New York metropolitan area.
- Teachers
  - conduct field trips for students to mechatronics lab;
  - raise funds to integrate mechatronics activities;
  - use mechatronics demos in their classes and labs;
  - develop new robotics curriculum;
  - initiate after school science and robotics research clubs;
  - disseminate their RET Site experience



Prototype Projects by Teachers

SMART

COVER STORY

Brooklyn Daily Eagle

& DAILY BULLETIN

Science-Oriented Kids from Across The U.S. Gather at Polytech Conference

Gathering Held in NYC for First Time; Students Housed at Marriott

YOUR NEIGHBORHOOD

BROOKLYN

Teachers go hi-tech

Taking Poly U science know-how back to HS

Brooklyn Daily Eagle

& DAILY BULLETIN

Polytechnic Program Helps Teachers Integrate High Tech into the Classroom

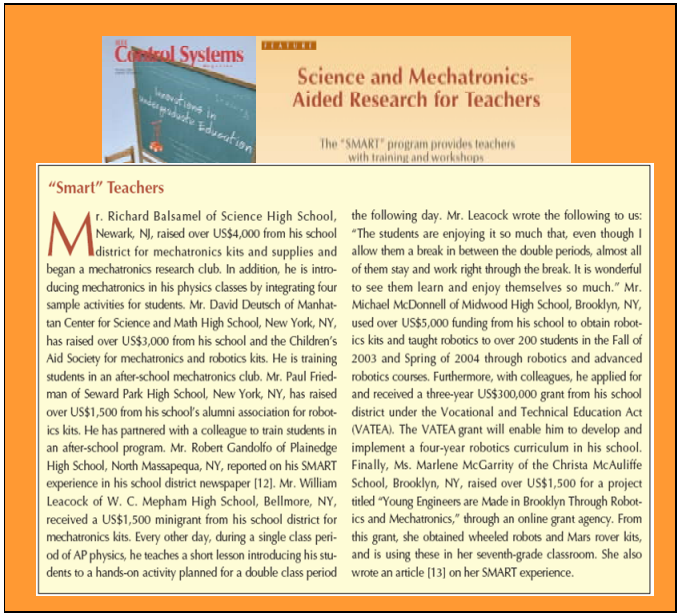
They Build Robots To Demonstrate Scientific Concepts and Laws

November 2003

Plaintalk

Plainedge Public Schools Community Newsletter

Engineering Teacher Constructs Mechatronics Device



Control Systems

FEATURE

Science and Mechatronics-Aided Research for Teachers

The "SMART" program provides teachers with training and workshops

"Smart" Teachers

Mr. Richard Balsamel of Science High School, Newark, NJ, raised over US$4,000 from his school district for mechatronics kits and supplies and began a mechatronics research club. In addition, he is introducing mechatronics in his physics classes by integrating four sample activities for students. Mr. David Deutsch of Manhattan Center for Science and Math High School, New York, NY, has raised over US$3,000 from his school and the Children's Aid Society for mechatronics and robotics kits. He is training students in an after-school mechatronics club. Mr. Paul Friedman of Seward Park High School, New York, NY, has raised over US$1,500 from his school's alumni association for robotics kits. He has partnered with a colleague to train students in an after-school program. Mr. Robert Gandolfo of Plainedge High School, North Massapequa, NY, reported on his SMART experience in his school district newspaper [12]. Mr. William Leacock of W. C. Mepham High School, Bellmore, NY, received a US$1,500 minigrant from his school district for mechatronics kits. Every other day, during a single class period of AP physics, he teaches a short lesson introducing his students to a hands-on activity planned for a double class period the following day. Mr. Leacock wrote the following to us: "The students are enjoying it so much that, even though I allow them a break in between the double periods, almost all of them stay and work right through the break. It is wonderful to see them learn and enjoy themselves so much." Mr. Michael McDonnell of Midwood High School, Brooklyn, NY, used over US$5,000 funding from his school to obtain robotics kits and taught robotics to over 200 students in the Fall of 2003 and Spring of 2004 through robotics and advanced robotics courses. Furthermore, with colleagues, he applied for and received a three-year US$300,000 grant from his school district under the Vocational and Technical Education Act (VATEA). The VATEA grant will enable him to develop and implement a four-year robotics curriculum in his school. Finally, Ms. Marlene McGarrity of the Christa McAuliffe School, Brooklyn, NY, raised over US$1,500 for a project titled "Young Engineers are Made in Brooklyn Through Robotics and Mechatronics," through an online grant agency. From this grant, she obtained wheeled robots and Mars rover kits, and is using these in her seventh-grade classroom. She also wrote an article [13] on her SMART experience.

NY1 and WABC

BROOKLYN HeightsPress & COBBLE HILL NEWS

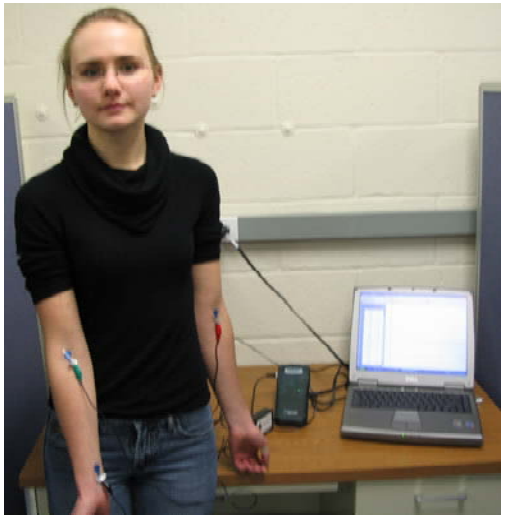
Robots Are Part of New Instruction at Polytechnic

RAISE: A GK-12 Project

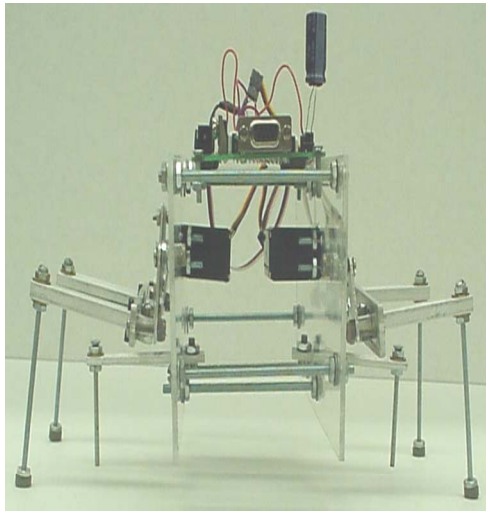
- **Academic Partners: Polytechnic University, HS: George Westinghouse, Marta Valle, Paul Robeson, and Telecommunication Arts & Technology**
- **Industry Partners: Con Edison, Symbol Technologies, FIRST, Honeybee Robotics, American Museum of Natural History**
- **People: 3 Faculty (2 engineering and one education), 13 RAISE fellows, 9 teachers, and ≈400 high school students**
- **Courses affected: Living Environment, Active Physics, Marine Science, Regents Physics, Math A**
- **Objectives**
  - **Elevating academic achievement in STEM disciplines**
  - **Entice and prepare an underserved student population for higher education and productive career opportunities in STEM disciplines**
  - **Provide technology literacy to students and teachers**
  - **Reinforce science and math skills of students**
  - **Provide professional development (PD) opportunities for NYC teachers**
  - **Build lab infrastructure for sensor-based STEM curriculum and instruction**
- **Fellows develop sensor-based lab experiments and demos to illustrate scientific phenomena**
- **Lab modules are designed such that every member in a group has an active role in the experiment**
- **Experiments demonstrate connections between real-life applications and high school science**
- **Integration of real-time sensors alleviates the drudgery of manual data collection and allows students to focus on concepts to be learned**
- **Senor-based labs and Vernier's LoggerPro software allow instructors to convey the material through a wide range of learning styles:**
  - **Graphical user interface displays sensor measurements through which visual learners easily pick up the concept**
  - **Team-based tasks require group effort which ultimately benefits auditory/verbal learners**
  - **Hands-on lab activities aid the tactile/kinesthetic learners**

Activities/Events

- **Technical training of RAISE fellows: mechatronics training in partnership with RET, exposure to sensing and data acquisition tools of Vernier Inc., and lab development**
- **4-day long education/pedagogy workshops for RAISE fellows by an education expert: lesson planning, questioning techniques, student behavior, cognition, learning theory and styles, classroom/group management skills, communication skills**
- **Technical workshop for RAISE teachers from partner schools: exposure to sensors and DAQ**
- **Election day (November 2, 2004) PD workshop attended by 20 teachers**
- **RAISE PD day workshop funded by NY Space Grant Consortium attended by 20 teachers**
- **1st Annual RAISE Career Day: April 20, 2005, 100+ attendees: teachers, students, industry professionals**
- **NYC GK-12 Meeting: May 20, 2005, http://gk12.poly.edu/Information/grant_holders_meeting.htm**

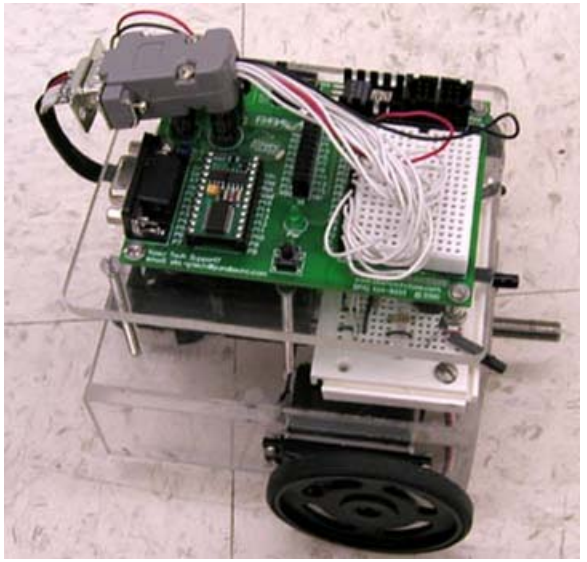


Youth in Engineering & Science: Summer Outreach

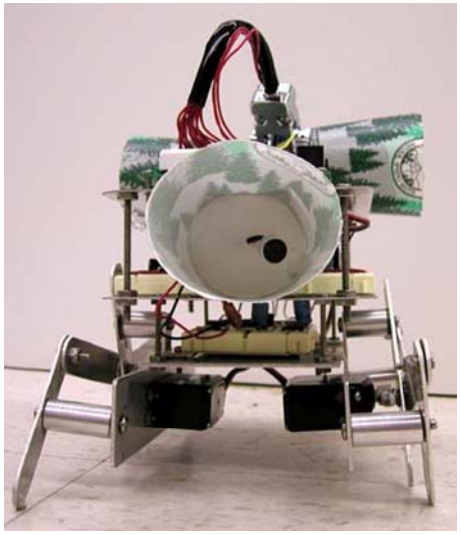


Four Legged Hexapod

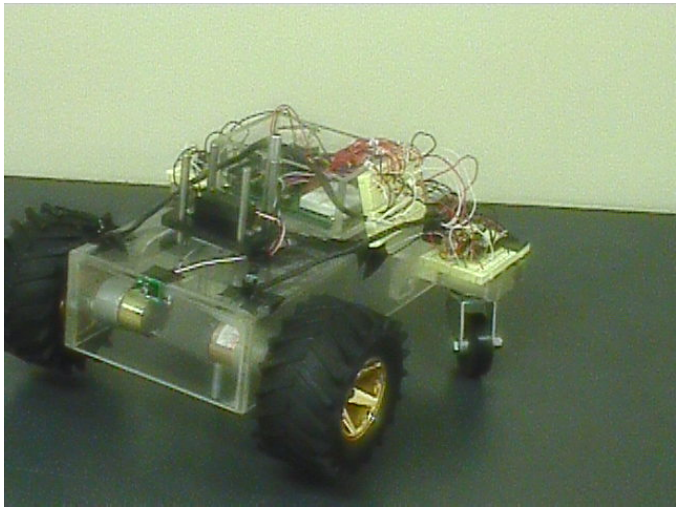
Polyurethane Applicator



Metal Mine Surveyor



Audio Enabled Hexapod



Autonomous Gardener

RoboVac

Acknowledgments—I

- **Funding: Over 2.6 million dollars since 1996**
  - **National Science Foundation, CCLI: 1999—2001, RET: 2003—2005, GK12: 2004—2007**
  - **National Aeronautics and Space Administration—Goddard Space Flight Center, 2001—Current**
  - **Air Force Research Laboratory—VACA, 1998, 1999, 2001**
  - **AFRL—VACA, graduate student summer support 2000, 2001**
  - **Orbital Research Inc., Cleveland, OH (SBIR company), 2000—2004**
  - **NASA/NY Space Grant Consortium, 1998—Current**
- **Companies**
  - **CRS Robotics**
  - **Feedback Inc.**
  - **Mathworks Inc.**
  - **Parallax**
  - **Quanser**
  - **Rixan**
  - **Vernier Inc.**

Acknowledgements—II

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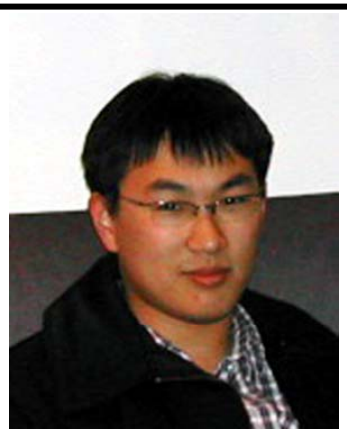
- **Graduated Students: Haizhou Pan (Ph.D.), Qiguo Yan (Ph.D.), Hong Wong (M.S.), Guang Yang (M.S.), Sang-Hoon Lee (M.S.), Dariusz Majewski (M.S.) and Yan-Fang Li (M.S.)**
- **Current Students: Hong Wong (Ph.D.), Sang-Hoon Lee (Ph.D.), Sookram Sobhan (M.S.), Saul Harari (M.S.)—DHS Graduate Fellow, and over a dozen GK—12 Fellows**


Saul Harari


Dong-Young Ko

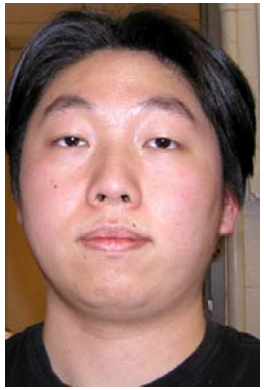

Sang-Hoon Lee


Yan-Fang Li


Isaac Osei


Dr. Haizhou Pan


Luis Sampedro


Hong Wong

Thank You