



Too often, people and nations ignore their own errors, shortcomings and complacencies.

Only after life deals them a harsh, scary lesson do they take action and change their ways

Securing America's Future by Developing STEM-based Bottom-up Learning



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Securing America's Future
by Developing STEM-based
Bottom-up Learning



Colin Bradbury
AS, B.Sc., B.Sc., MBA, Ph.D.



The New Arms Race

- Drone Surveillance - Predator
- Drone strike capability – Reaper
- Air/Ship Integration
- Autonomous air and surface vehicles
- New capabilities
 - Detect and avoid
 - Close and kill
 - Co-operative swarming



Future Wars
will be fought
primarily
Robot versus Robot



Requirements for Winning

- Competent and experienced engineers
- Competent and experienced technicians
- Competent and experienced technical leadership
- Now and in the future



Deepwater Horizon

Would this have happened with

- Adequate supply of engineers
- Fleet of underwater vehicles
- Better plan to deal with the catastrophe





Current Trends

- Technology Development
- Corporate Hiring Practices
- College Education





Technology Development

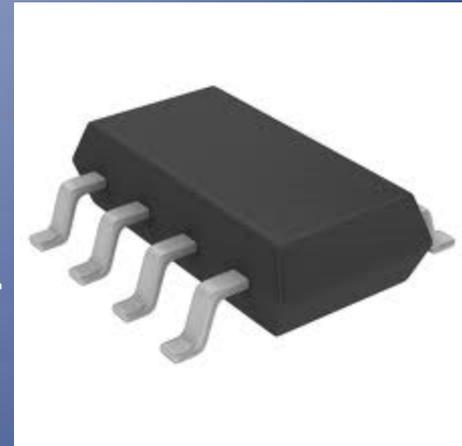
- Process shrinkage
 - Devices are becoming smaller
- Greater Integration
 - More functionality in any given package
 - System On a Chip
 - Embedded cores
- Higher Speeds
 - Signal integrity issues





Technology Implications

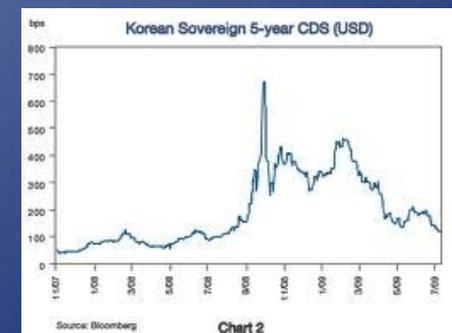
- More things to consider in a design
 - Longer design time
- Migration from hardware to firmware
 - Fabricate chips now, program them later
- More specialized knowledge needed
 - Too many knowledge areas for one person
- Bigger product design teams
 - Increased interaction between specialists





Corporate Viewpoint

- Duty to the shareholders
 - Maximize share price
 - Maximize dividends
- Develop products as fast as possible
 - Time to market is absolutely critical
- Procure talent at the lowest possible cost
 - Find trained engineers
 - Pay them as little as possible





Corporate Viewpoint (Cont'd)

- Worldwide manufacturing capability
- Worldwide pool of engineering talent
 - Cross-border development to minimize overall development cost
- Engineering Pipeline?
 - H-1B visas, 65000/year, 3 years + 3 years
 - L-1B visas, specialized knowledge
 - O-1 visas, extraordinary ability
 - TN visas, NAFTA list of professions



College Education

- Funding cutbacks
 - Fewer classes being offered
 - Semesters being shortened
- Higher Tuition Fees
 - Lower intake
- Net effects
 - Fewer students graduating
 - Graduating with inadequate knowledge
 - Educated Idiots



**MY
COLLEGE
SUCKS**





Research in Autonomous Robotics and
Undergraduate Institutions

Michael George, Ph.D.



Motivation for hands-on research during undergraduate training

- Studying and learning in a class is a progressive, linear activity



Motivation for hands-on research during undergraduate training (cont.)



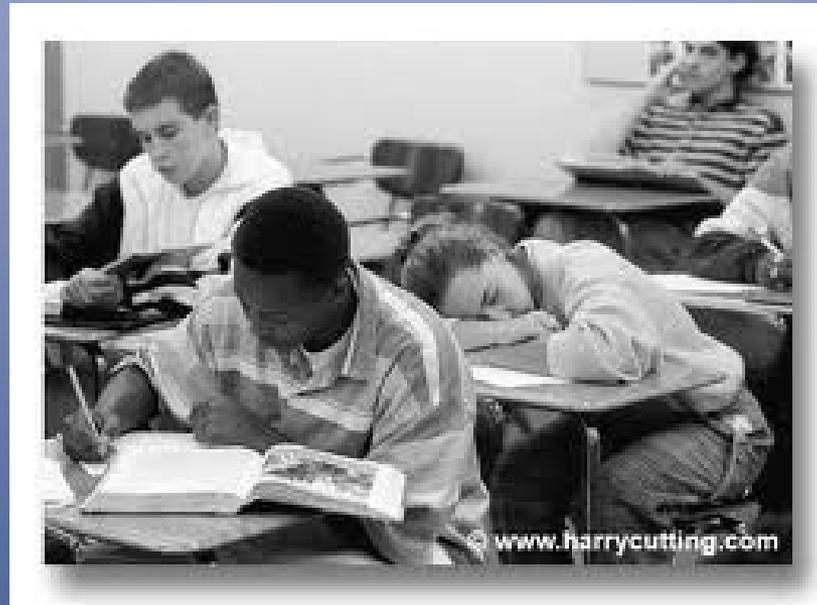
- Benefits from a research project
 - birds-eye view of the operation of a company
 - work in a specialized niche position
 - discover abilities and develop practical skill

Motivation for hands-on research during undergraduate training (cont.)



- academic environment
 - demanding
 - constructs an intellectual box around the student

Research on Autonomous Robotics at an Undergraduate Institution



- Principal problem: Student participation
 - Numerous distractions from the research.
 - Discontinuity from one year to the next

Research on Autonomous Robotics at an Undergraduate Institution (cont.)

- Research for students with
 - Work on worthwhile projects, such as development of autonomous robots
 - In the strategic interest of the United States, as funding for basic scientific and engineering research is drying up



Research on Autonomous Robotics at an Undergraduate Institution (cont.)

- Planning of the project
 - requires faculty advisors or consultants
 - students who have some experience from previous years.
 - set reasonable goals from prior year's benchmarks.



Research on Autonomous Robotics at an Undergraduate Institution (cont.)

- Training
 - Students are paired up and assigned
 - Training in basic scientific methodology
 - Papers studied the autonomous robots



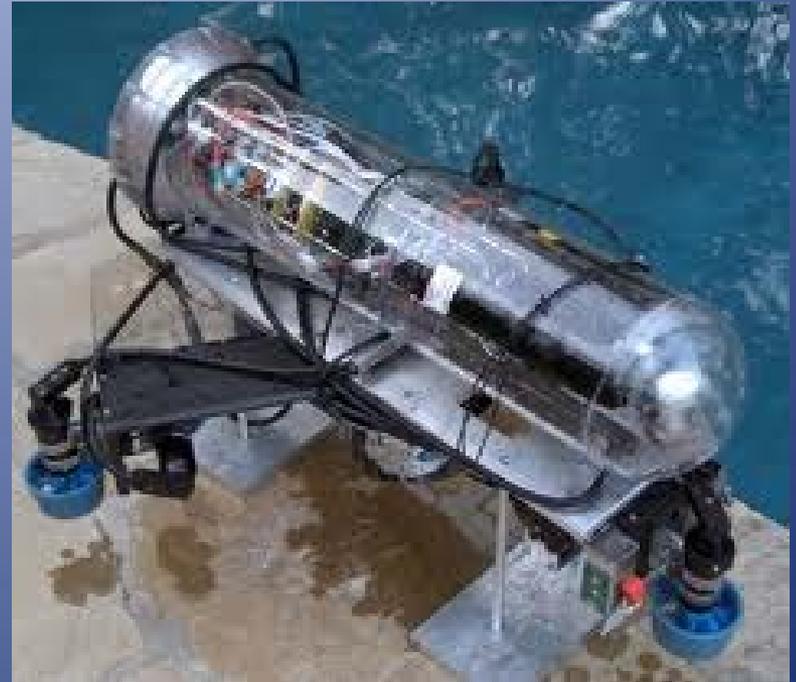
Development of engineering and scientific skills of students

- Central foci
 - Competing in the AUVSI competition held at SPAWAR each year
 - Develop intuitions for fluid mechanics.
 - Incrementally improve system, from an initial design framework.



Development of engineering and scientific skills (cont.)

- Development process for students
 - Organizational work
 - Manufacture of the robot.
 - Find research niches and specialize
 - Learn to budget overall limited time and resources.



Development of engineering and scientific skills (cont.)

- Skill development
 - Good opportunity to develop careful and precise laboratory skills for engineering and scientific work.
 - Need to carefully schedule time and effort
 - Synchronize work with others

Performance competition

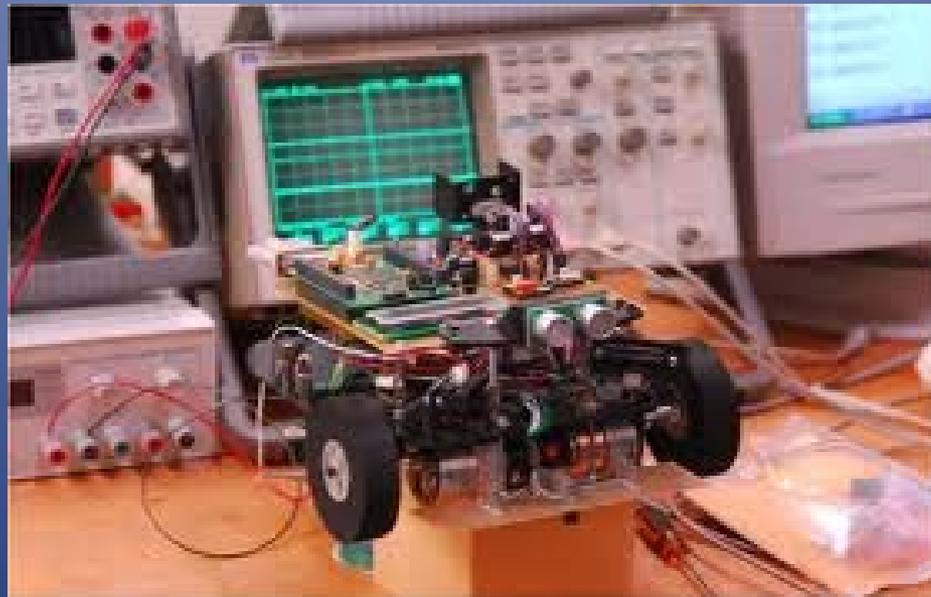
- Value of competition
 - What can be realistically accomplished
 - How can effort be constrained to improve over last year
 - Many practical problems can arise
- Students have various idealistic goals
 - Forced to face a hard reality of time pressure
- Lack of continuity, with student turnover each year, is a severe constraint.

Development of engineering and scientific skills (cont.)

- Strategies optimize the performance of the robot.
 - Often arise in the course of the competition
- The competition centers around
 - Sensors
 - The level of computational intelligence required to integrate the sensors in the robotic system.

Cracking the puzzle: integrate control systems, sensors and mechanical systems (cont.)

- We discount the abilities and contributions of amateurs in our culture, while these contributions can be very positive and not trivial.



Autonomous robotics: positive vision of the future (cont.)

- Young students focus on ideal (often linear) or well-explored examples
- Technology is very powerful
- It can be a tremendous awakening for a student to see the “real” world
- Must recognize the importance of careful observations





Christopher-Lorenzo Carter
President
Pacific Nautilus

Partners

- Society Woman Engineering-SDMC
- Phi Theta Kappa-SDCC
- Pacific Asian Society Engineers -SDSU
- International Society of Electronic and Electrical Engineers-SDSU



- Pacific Nautilus is a Not-For-Profit Student Organization
- Dedicated to increasing student participation of :

- Historically underrepresented
- High school
- Community college
- University



- We specifically encourage, but are not limited to, undergraduate STEM based research with an emphasis on autonomous systems.



- Universities expose engineering students to top-down learning which we hope to supplement with bottom-up learning
- Through participation in Autonomous Vehicle Competitions hosted by AUVSI



Pacific Nautilus is uniquely qualified for this.



- The IGVC: very cutting edge of engineering education.
- multidisciplinary,
- theory-based,
- hands-on,
- team implemented,
- outcome assessed,
- and based on product realization.



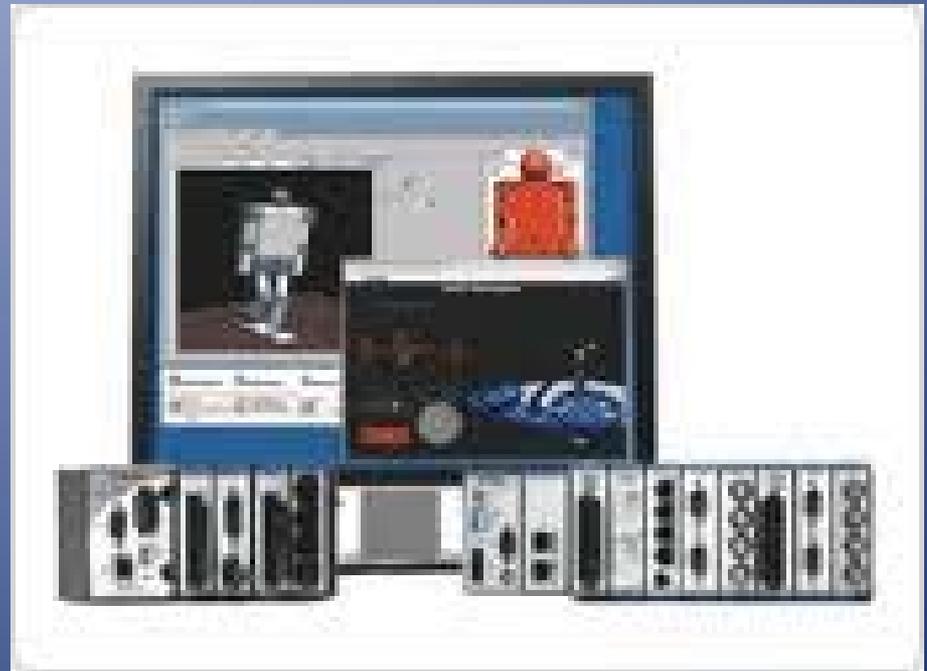


Autonomous System Design

Research



System Design

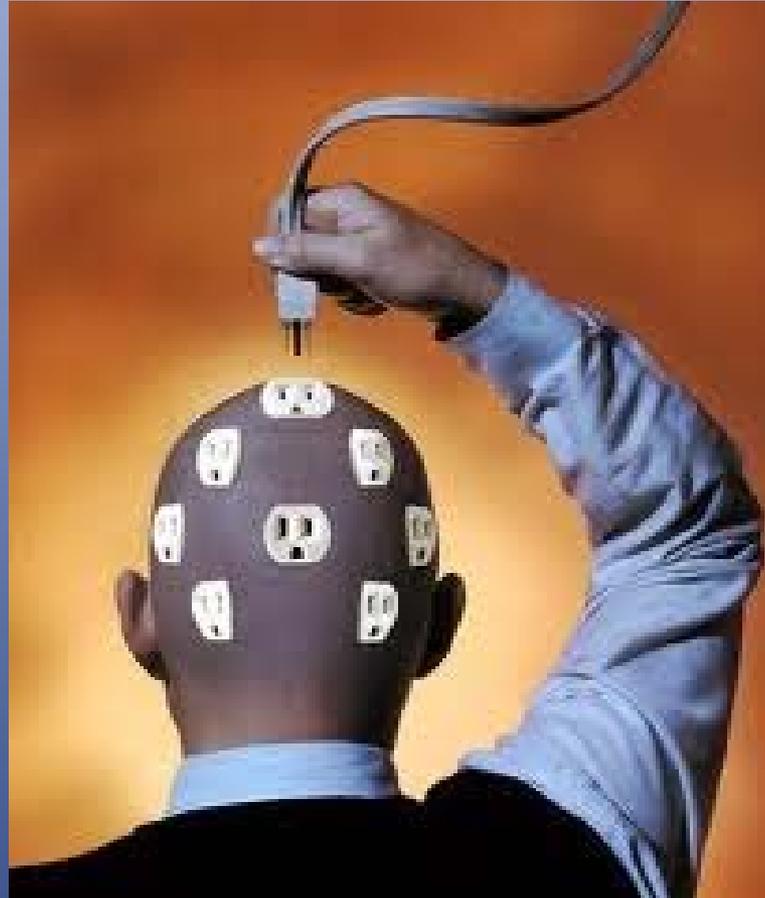


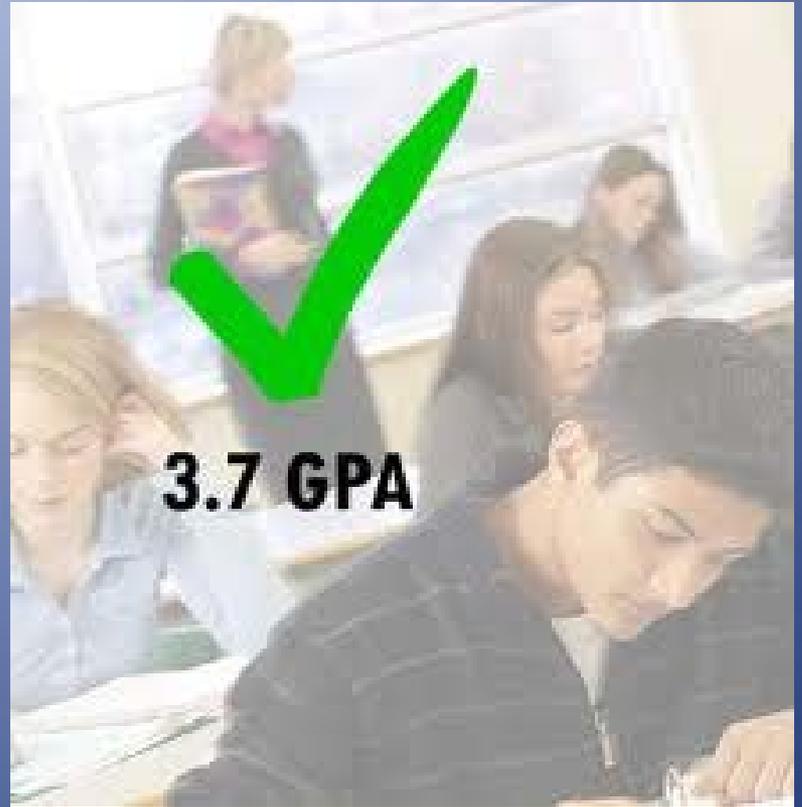
Business





Student Disconnect











How can undergraduate research improve our national security?



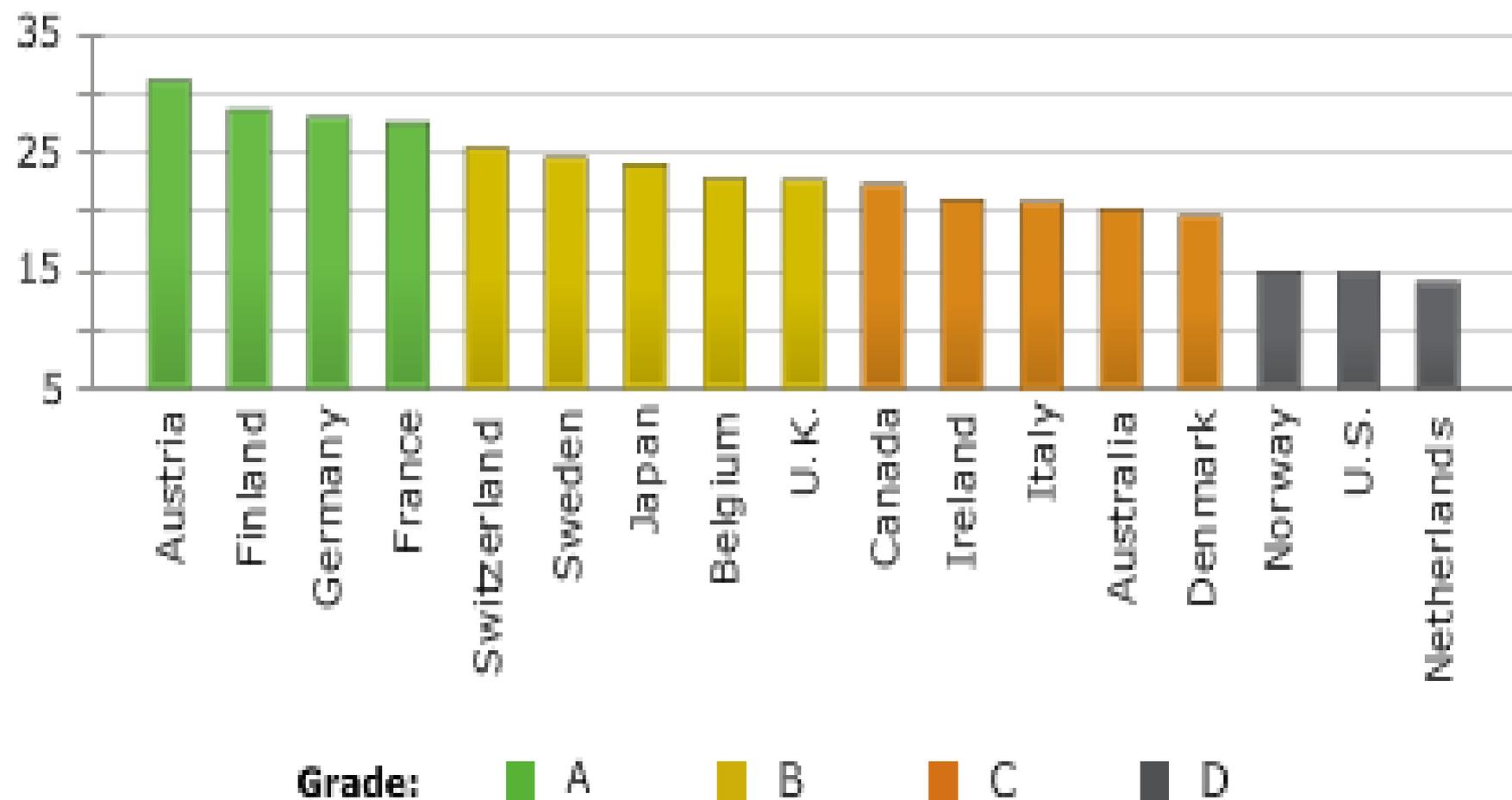
Ron Worley
Professor of Engineering

Graduates in the Seven Disciplines

	Engineering and engineering trades	Life sciences	Computing	Physical sciences	Architecture and building	Mathematics and statistics	Manufacturing and processing
Australia	D	C	A	C	C	D	B
Austria	B	C	A	C	A	C	C
Belgium	B	B	D	C	C	C	D
Canada	C	A	D	B	D	C	D
Denmark	C	D	D	C	A	C	D
Finland	A	D	C	C	C	C	A
France	C	B	C	A	C	B	A
Germany	C	C	B	A	B	A	B
Ireland	D	D	C	D	D	D	B
Italy	C	C	D	D	A	C	A
Japan	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Netherlands	D	D	C	D	C	D	C
Norway	D	D	C	D	C	D	D
Sweden	A	C	D	D	C	D	C
Switzerland	B	B	D	A	B	C	D
U.K.	D	B	C	A	B	C	B
U.S.	D	B	D	D	D	C	C

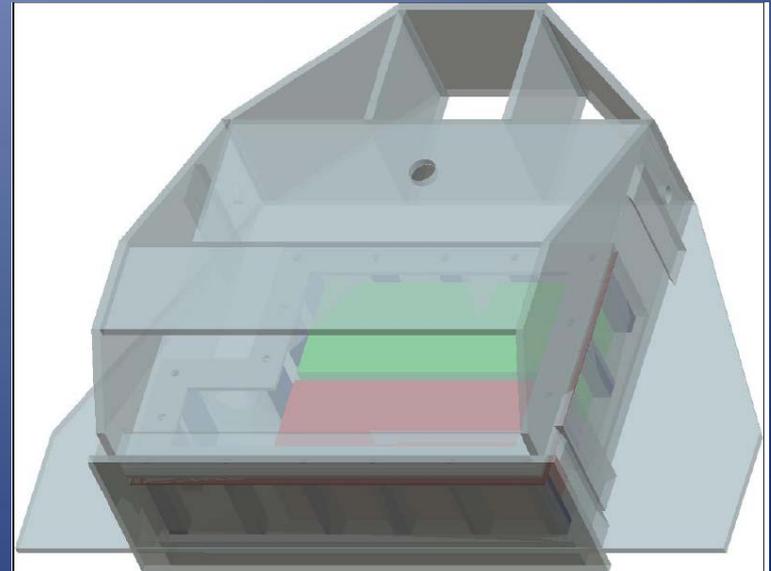
Science, Math, Computer Science, and Engineering Graduates, 2007

(proportion of all graduates in 2007)





Hands-on experience

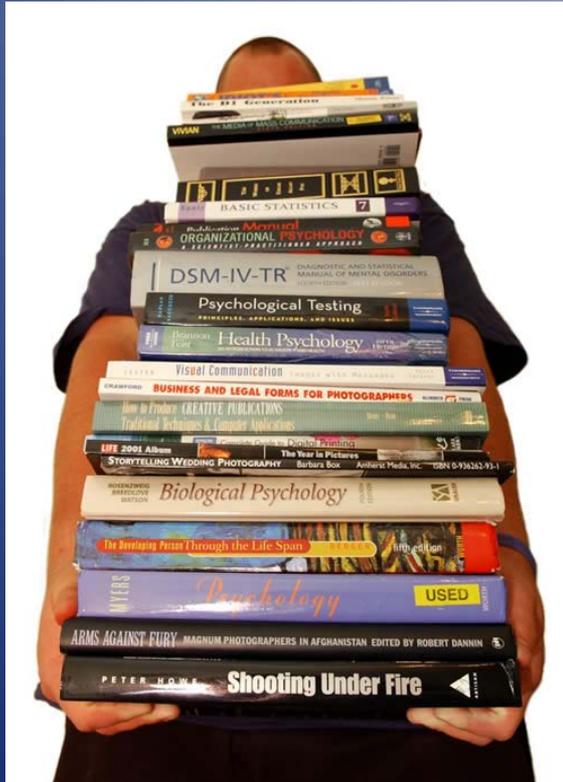




The best teacher



Exponential growth of information





AUVSI Foundation and ONR's 14th International RoboSub Competition

Co-sponsored by the Office of Naval Research (ONR)

- Advances Autonomous Underwater Vehicle (AUV) Technology
- Challenges the next generation of engineers
- Foster ties between young engineers and AUV companies