The Talent Imperative in Science and Technology

An Evaluation of Army Educational Outreach Programs

A Report to the Director for Research and Laboratory Management

Presented by

BEST
Building Engineering & Science Talent

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THE TALENT IMPERATIVE IN SCIENCE AND TECHNOLOGY: AN EXTERNAL EVALUATION OF THE ARMY EDUCATIONAL OUTREACH PROGRAM

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BEST is a 501(c) 3 organization established in 2001 with seed funding from seven federal agencies including the Department of Defense to broaden the participation of historically under-represented groups in the U.S. technical workforce. BEST conducted a Congressionally mandated national search for the nation's most effective K-12, higher education, and workforce programs in science, technology, engineering, and mathematics. John Yochelson is former president of the Council on Competitiveness. Kelly Carnes is former Assistant Secretary of Commerce for Technology Policy. Mary McCain is former Senior Vice President of the American Society for Training and Development.

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Army Educational Outreach Program (AEOP) External Evaluation

Statement of Task

The U.S. Army has a vital stake in strengthening our nation's pool of technical talent. With its compelling mission, distributed research assets, and skilled workforce, the Army is also well positioned to help meet the nation's talent imperative in science, technology, engineering, and mathematics (STEM).

The Army's competitive advantage in STEM education lies in sparking interest, building skills and providing a rich set of research opportunities. The defining feature of the Army Educational Outreach Program (AEOP) is its capacity to connect textbook learning with real world science, technology and engineering challenges. This capacity is rarely found in K-12 or university classrooms, but plays a pivotal role in shaping student attitudes toward, and commitment to, STEM fields. It builds on the strengths of the Army's human capital, state-of the-art facilities, and far-reaching network of research partnerships.

The Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASAALT) asked Building Engineering and Science Talent (BEST) to conduct an external independent review of AEOP. Specifically, the director of Army laboratory research and management tasked BEST to (1) provide a baseline on existing educational outreach program activities; (2) identify measurable goals and metrics associated with these activities; (3) identify beneficial program activities that are not being undertaken within the current AEOP portfolio; (4) identify additional collaborative opportunities within the Army S&T community; and (5) suggest individual or collaborative activities linking AEOP to the outside community.

Summary of Analysis and Recommendations

I. Baseline of Current AEOP Activities

ANALYSIS

- **ASAALT has led the way in STEM education within DOD by molding a widely dispersed and largely disconnected set of activities into an Army portfolio of 17 programs (profiled in the body of this report). Since its establishment in 2004, AEOP has:**

  - Created a corporate brand and DOD-wide visibility for the Army's education and outreach efforts;
  - Created a web-accessible core of AEOP programs;
  - Generated a body of corporate knowledge regarding these programs, which BEST has supplemented through research and interviews in the body of this report;
  - Established an AEOP program coordination mechanism;
  - Developed a universal application to facilitate participation in AEOP programs; and
  - Put in place a Human Subjects Protocol to support program evaluation.

• The Army's groundbreaking effort to develop an integrated portfolio could be refined and enhanced in three key areas: goals, program criteria and program categories.

Goals: AEOP brings together component programs that were established over the past two decades under varying conditions and to respond to evolving needs. While all reflect the Army's commitment to STEM education, the wide-ranging mix of individual program goals diffuses the strategic focus of AEOP and blurs the rationale for investing in educational outreach. Establishing a common set of priority goals across programs will produce a more cohesive and clearly aligned AEOP portfolio.

Program criteria:
The Army has not yet spelled out the rationale for including educational outreach programs under the umbrella of AEOP. Doing so will increase the transparency, credibility, and integration of the portfolio.

Program Categories:
Currently, programs are clustered according to grade levels, rather than as a sequence that begins with programs that spark interest, continues with opportunities to develop hands-on knowledge and career awareness, and offers support to sustain engagement in STEM fields through to entry into the workforce. This focus on sequential opportunities can be enhanced through a simplified program structure focusing on two key categories: research opportunities and competitions.

RECOMMENDED ACTIONS:

Goals:
1) Establish a common set of goals that convey AEOP's unified purpose to internal and external audiences.

- Increase the interest and awareness of students from all backgrounds in STEM fields;
- Develop high-potential U.S. talent for careers in science and technology; and
- Attract a fair share of available talent to the Army S&T community.

Criteria:
2) Spell out components to qualify for inclusion in AEOP. Develop guidelines that lay out what it takes to be included within the AEOP portfolio.

Categories:

3) Adopt program categories that capitalize on the Army's competitive advantage in STEM education by laying out a continuum of opportunities to introduce, engage and sustain students in STEM interest and education:

- Research Opportunities:
  - Inclusive introductory research opportunities
  - Advanced research opportunities for high-potential students

- Competitions:
  - Inclusive introductory experiences
  - Advanced experiences for high potential students

AEOP Program Criteria

1. Goals. Every program will have clearly defined goals that are (1) consistent with AEOP as a whole; (2) fully understood by all program participants; and (3) spelled out in all promotional materials

2. Impact. Every program will have a significant impact in at least one community, or will draw participants from a national base. The determinants of impact will include (1) number of students reached; (2) number of volunteers engaged; and (3) scope, intensity, and duration of the program.

3. Inclusiveness. Every program will embrace students from (1) varying racial and ethnic backgrounds' (2) all income levels, and (3) populations that are historically under-represented in STEM disciplines and careers.

4. Quality. Every program will provide a quality experience to all participants. Such an experience requires (1) challenging content; (2) supportive mentoring relationships; (3) recognition of participants as individuals; and (4) a commitment to continuous program improvement.

5. Management. Every program will develop and periodically update a concise management plan linking goals and resources. Program budgets will be routinely submitted to the AEOP management team.

6. Metrics. Every program will collect sufficient data to determine whether its goals are being met. These data will vary by program but will generally include (1) students reached; (2) volunteers engaged and hours committed; (3) costs; and (4) pertinent outcome indicators of interest in STEM, increased skills, continued participation in AEOP programs, and pursuit of STEM careers.

7. Connectivity. Every program will position itself as part of a continuum of AEOP opportunities rather than as a stand-alone intervention. Participants in every program will be routinely alerted to follow-on possibilities.

8. Continuous Improvement: Every program will be made aware of best practices and will demonstrate incremental or other improvements as part of annual evaluations.

9. Communications. Every program will be profiled on the AEOP website, which will serve as the hub for creating an AEOP community.

10. Volunteers: Every program will value and recognize the indispensable contribution of volunteers to effective STEM outreach.

II. AEOP Metrics

ANALYSIS

AEOP has excelled in developing metrics for program management, but is not in a comparably strong position with respect to the measurement of program effectiveness:

- AEOP has assembled data to compare program costs, improve program efficiency, increase the accountability of managers, and allocate scare resources among programs.
- It has proved far more challenging to demonstrate the impact that AEOP programs are having on STEM education outcomes.
- The thin base of research evidence linking AEOP programs to STEM outcomes has the potential to limit both the funding and credibility of AEOP in today's results-driven environment.

The varied range of AEOP programs rules out a one-size-fits-all approach to data collection and requires both common and program-specific metrics.

- Each individual program collects quantitative and/or qualitative data, most of which is gathered by local Army or university labs or is based on survey sampling (e.g. JSHS participants).
- The BEST report provides program-by-program recommendations for reinforcing existing metrics and data collection.

RECOMMENDED ACTIONS:

4) Ensure that all of the Army's major programs – eCYBERMISSION, GEMS, SEAP, MWM - are externally evaluated by STEM education researchers in order to substantiate the credibility of AEOP program outcomes and impacts.

5) Use the newly developed Human Subjects Protocol to begin collecting longitudinal data on students participating in major programs.

- Adapt the existing GEMS and/or MWM pre and post-testing student surveys for use by the other AEOP programs.
- Provide online and/or in person training on use and customization of this tool.

6) Collect information on volunteers—a critical enabler of program success—including numbers engaged and time committed to AEOP and other education outreach activities.

III. Bolstering AEOP program activities through collaboration and best practice

ANALYSIS

The capacity of current AEOP programs to make an increased impact within existing resource constraints hinges on five main factors:

- ***Program management:*** AEOP program management runs the gamut from full time to part-time, from outsourced to in-house, and from paid staff to volunteers. Moving beyond these patchwork arrangements is essential for the long-term success of AEOP.

- ***Volunteers:*** One of AEOP's greatest assets is the high level of engagement of committed volunteers. Many of these volunteers are stretched thin and policies governing volunteer time—both stated and unstated—vary dramatically between and within laboratory locations. AEOP cannot continue to grow without expanding the pool of volunteers and deploying them productively.

- ***Connectivity:*** The vision of AEOP has always been to provide more than a one-time learning experience. Linking program opportunities along the educational continuum will deliver greater value to individual students and tie component programs more closely together. Currently there is a gap in program options for students in grades 8-12: Successful eCYBERMISSION and GEMS students who wish to pursue more challenging opportunities have limited options if they cannot achieve competitive entry into SEAP or one of the higher-education level internship programs.

- ***Continuous improvement:*** A hallmark of the nation's most effective STEM education programs is their ability to learn from their own experience and from others. Information on best practice components from other AEOP, DoD or education outreach programs is not readily available for AEOP programs to adopt and adapt. Existing processes and activities tend to remain static.

- ***Program Promotion.*** Each AEOP program is promoted independently, including materials with logos of the individual programs. Many Army locations are unaware of the range of AEOP programs that they may incorporate into their outreach activities. Further, programs that rely on Army volunteers for outreach (as opposed to UNITE, REAP, etc.), require one-on-one outreach to individual teachers, schools and families. This "retail" approach takes significant amounts of time and is slow in reaching critical mass. This approach alone will not take AEOP to the next level.

RECOMMENDED ACTIONS:

Program Management:

7) Replace AEOP's current patchwork of management approaches with a more centralized management structure that allows for greater collaboration and economies of scale.

- Combine support functions in areas where programs have common needs, such as: managing applications, making stipend payments, and program promotion. This should create significant synergies and efficiencies, make it easier to expand existing programs to new locations, and save AEOP money in the long run.
- Map the variety of Army STEM activities which are locally undertaken and informal, in order to determine if there are linkages between these and AEOP programs which might offer mutual support and enhance impact.

Volunteers:

8) Increase the participation and satisfaction of volunteers.

- Develop an Army-wide policy about allowable time for volunteer service (SMDC has such a policy), during and after the regular workday. Currently, policies appear to vary dramatically between and within laboratory locations.

- Provide "turnkey" materials, modeled on those for eCYBERMISSION, to reduce some of the difficulties in orientation and time commitment that volunteers face.
- Expand the definition of "Ambassadors" to encompass each of the Army volunteers who develop relationships with schools, with a particular focus on serving the needs of those schools and teachers that have opted to participate in any of the AEOP programs.
- Ensure that volunteer service is appropriately recognized and rewarded (extra credit, not mandated efforts) in annual performance considerations, to the extent permissible under Army personnel regulations.
- Celebrate standout volunteers and their managers at high-profile Army events.

Connectivity:

9) Build stronger Pathways between programs

- Expand the GEMS—SEAP—CQL progression, which is a good foundation on which to build a set of explicit pipeline programs.
- Expand the range of lab-based learning opportunities for students in grades 8-12. Address this "gap" in the portfolio through: expansion of GEMS to the extent possible, creating a simplified non-competitive hands-on research and mentoring program track (using SEAP or other similar authority), and describing and linking REAP, JSHS, and eCYBERMISSION more directly.
- Develop a single, simple internship authority that combines the best features of the variety of available internship programs—SEAP, SCEP, STEP, SROP, etc.—which can then be customized to meet the needs of each Army laboratory, and the diverse needs and interests of individual mentors and students. This will enable the AEOP programs focusing on middle and high school students to more easily identify opportunities for high-potential students entering higher education programs, and to make those opportunities known to the students.
- Expand opportunities for additional eCYBERMISSION participants (not just winners) to move into hands-on research experiences to the extent practical, given geographical and capacity limitations.
- Encourage students who have successfully completed introductory research experiences (such as GEMS, REAP and UNITE) to consider entering a competition in their area.
- Increase the Army's connection to JSHS and ISEF, and actively recruit participants into advanced Army research experiences.
- Use the AEOP web site to increase students' awareness of opportunities to bridge to the next level. Actively disseminate information on AEOP follow-on opportunities to all students with an AEOP connection.

Continuous Improvement:

10) Equip managers and volunteers to be more effective mentors by sharing best practices, developing "how to" materials, and conducting workshops

- Gather existing practice among labs and other organizations and develop "how-to" materials to share mentoring best practices.
- Sponsor a Mentoring Workshop led by nationally recognized leaders in mentoring.

11) Provide policy guidance on drawing students from more diverse talent pools into AEOP

- Develop standard ways (adapted from appropriate best practice) to identify and draw science-oriented students into inclusive introductory-level research experiences and competitions.
- Offer high potential students—drawn from this broad group—advanced research opportunities that provide challenging content research experience, mentoring and skills training, and provide information on competitive opportunities to these students.

Program Promotion and Dissemination

12) Enhance the collaborative dimension of program promotion.

- Increase the promotion of AEOP as a portfolio rather than component programs:
  - Develop an AEOP branded and inclusive set of materials to use in national promotion, demonstrate the continuity of opportunities for students, and to add to materials for individual program promotion to particular audiences; and
  - With input from Army leaders, POCs and others, develop a single message that annually promotes the full spectrum of AEOP to all labs and installations.

- Continue developing the AEOP web site into a user-friendly "one-stop-shop" for Army STEM education and career information:
  - Categorize opportunities from the user's perspective (e.g., competitions, internships, etc);
  - Provide information on opportunities beyond AEOP programs the Army supports that are available in many geographic locations;
  - Create a fun and tech-savvy look and feel that compares with the digital communications experience most students have; and
  - Use the AEOP web site—or develop another site—to connect high-potential students with Army career information and job opportunities.

IV: Identify Collaborative Opportunities within the Army S&T Community

ANALYSIS

Taking AEOP to the next level will require tapping the potential of three key targets of opportunity, each of which needs an individually tailored strategy:

- *Increased participation by the Army Corps of Engineers;*
- *Outreach capabilities of academic partners; and*
- *Closer ties to minority-serving institutions.*

***Increased participation by the Army Corps of Engineers*:**

- **The COE participates in extensive number of programs, the majority of which are local or are managed by another organization:**
  - ERDC labs routinely participate in programs whose infrastructure is funded elsewhere (FIRST, WISP, LSAMP, IMPRINT).
  - While ERDC's commitment to STEM outreach is exemplary, its approach remains fragmented. There are many over-lapping lab-based experiences with no unified strategy connecting them.

- **The only AEOP program in which ERDC labs participate is SEAP, but these instances appear to operate without strong connection to the Army's overall SEAP program.**

Tapping the outreach capabilities of academic partners:

- Education outreach within academic partners in UARCs, Centers of Excellence and CTAs appears to be driven by the particular culture and tradition of the universities, rather than awareness/use of AEOP programs.

Building closer ties to minority-serving institutions

- One of the few programs that appears to "connect the dots" is the ERDC pipeline to University of Puerto Rico Mayaguez, which seems to supply students to Champagne Urbana as well as the Vicksburg labs (and possibly others).
- As with other Army commands, however, the majority of ERDC's outreach and joint activities with HBCU/MIs is developed independently by labs and based on proximity rather than strategies that link ERDC R&D needs to a particular HBCU/MI, either for complementary research or for pipeline for HBCU/MI students.

RECOMMENDED ACTIONS:

13) Integrate Corps of Engineers education outreach program activities into AEOP by:

- Establishing a POC for the COE based in Vicksburg or at headquarters to start connecting the dots more effectively;
- Developing initial collaborative activity with ERDC, which though only a small part of the Corps of Engineers, appears to be the right place to start because of the R&D link; and
- Promoting participation in eCYBERMISSION, which appears to be a natural fit in areas where there is extensive community outreach.

14) Take advantage of Corps of Engineers expertise to expand student opportunities in engineering.

- Create an pre-engineering equivalent to GEMS; and
- Expand exemplary Corps of Engineers programs, such as the WISP, to other labs, locations and universities. For example, a similar partnership could be explored with Carnegie Mellon, which has an outstanding track record of encouraging women to pursue degrees in computer science and engineering.

15) Make AEOP an integral part of the Army's relationships with all academic partners:

- Include language in academic partner agreements encouraging a focus on STEM education. NSF and the Materials Center of Excellence offer good model language.
- Prepare and distribute user-friendly information to academic partners and students about opportunities for students to have meaningful work experiences in Army labs.
- Strategic planning to identify potential new academic partners producing talent critically needed by the Army. Decrease emphasis on geographic proximity as the driving force for partnership. (Univ. of Puerto Rico—Mayaguez offers a good model).

16) Engage Army locations that work informally and formally with HBCU/MIs, in order to develop a more strategic and mutually valuable approach to these relationships.

- Develop a matrix of HBCU/MIs, their infrastructure and capability, subject-matter expertise and therefore potential for complementary R&D, and/or the possibilities or providing students for undergraduate or graduate internships.

- Ensure that Army labs and HBCU/MIs are mutually aware of programs such as JSHS, UNITE, REAP, and others in order to provide maximum exposure for under-represented students to STEM awareness and education.

- Clarify and provide examples of "best in practice" methods drawn from labs and HBCU/MIsD in developing Education Partnership Agreements or other types of formal agreements and in setting expectations that are realistic and tailored to the capacity of the local institution and the Army lab.

V. Suggest how AEOP contacts and collaboration with the external STEM education community can be mutually beneficial.

[A brief overview of these organizations is included in Appendix III]

ANALYSIS

AEOP could be enriched and strengthened through greater contact with the STEM education community.

- Army STEM education and outreach activities take place among a wide array of local, regional and nationwide activities, which are managed and funded by government, non-profit and corporate stakeholders.
- The Army can leverage its resources to lead to greater impact through establishing mutual awareness and complementary activities with like-minded STEM education stakeholders.

AEOP can develop national awareness of programs, such as eCybermission and GEMS, through promotion by membership organizations via their websites, conferences, and newsletters.

- There are a number of membership organizations for teachers of STEM from K-12 through post-secondary university, as well as organizations of minorities and other under-represented groups.
- Membership organizations typically provide a wide variety of resources to their members and information to the public, including links to materials and curriculum; information about programs for use by teachers, parents and students, networking opportunities online or during conferences.
- Successful outreach to individual teachers for participation in programs such as eCYBERMISSION, GEMS or science fairs may be more rapid as larger numbers of teachers become aware of these programs via their associations.

AEOP can broaden the pool of students for participation in AEOP programs, who typically must be recommended by teachers, by providing information to larger numbers of teachers about these options via their associations.

RECOMMENDED ACTIONS:

17) Introduce AEOP to targeted organizations in the metropolitan area through individual meetings and mailings. Target organizations include:

- *Society of American Military Engineers* (Alexandria, VA)
- *Association for Women in Science* (Washington, DC)
- *National Society of Black Engineers* (Alexandria, VA)
- *American Indian Science and Engineering Society* (Albuquerque, NM)
- *Society of Professional Hispanic Engineers* (Los Angeles, CA)
- *American Chemical Society* (Washington, DC)
- *National Science Teachers Association* (Arlington, VA)
- *National Council of Teachers of Mathematics* (Reston, VA)
- *American Society for Engineering Education* (Washington, DC)
- *National Alliance of State Science and Mathematics Coalitions (*Arlington, VA)
- *National Action Council for Minorities in Engineering (*White Plains, NY)

18) Collaborate with selected STEM Stakeholders who offer programs in communities near Army labs.

19) Convene an advisory group of STEM stakeholders, including those who have partnered with Army education programs and those who have not, to provide input on AEOP programs and activities, and explore partnership opportunities.

Introduction, Approach, and Context

Introduction

The U.S. Army currently enjoys an unprecedented level of technological superiority across the full spectrum of its military missions. Maintaining this technological edge requires a dynamic portfolio of scientific research and technology development, a culture of innovation, and the capacity to draw upon diverse ideas and approaches.

The Army's science, engineering, and technology workforce is at the heart of this innovation process. The Army employs over 25,000 scientists and engineers, and supports world-class basic and applied research through a wide-variety of university partnerships and grants to individual researchers. These professionals not only devise technological solutions to meet specific Army needs and challenges, but also create leap-ahead technologies and systems. In short, sustaining a high quality cadre of scientists, engineers, and technology professionals—both within Army laboratories and throughout the Army's extended research network—is instrumental to today's war fighting and the Army's capabilities of the future.

A number of factors have the potential to jeopardize the Army's capacity to remain a premier R&D organization. These include: pending retirements and the need to hire more than 10,000[1] scientists and engineers in the near future; intensified competition from the private sector for the best and brightest technical talent; incentives that draw young Americans into career paths other than science and engineering; as well as a changing labor market, and the long lead time that is required to develop science, technology, engineering and mathematics (STEM) talent. In response, the Army faces the need to develop a strategic and well-executed approach to workforce development from the beginning of the education pipeline.

In addition, as one of the nation's most powerful and visible institutions, the Army has invariably defined its stake in developing human capital in broad national terms. The growing sense of national urgency over the preparation and interest of American students in technical disciplines has also helped place STEM education and outreach at the top of the Army's agenda. With its rich and diverse array of technical assets and resources, and focus on research and engineering to meet real world challenges, the Army is very well-positioned to contribute to meeting these national goals.

To strengthen and provide greater strategic focus for the Army's STEM education and outreach efforts, the Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASAALT), established the Army Education and Outreach Program (AEOP) in 2004. AEOP provides an umbrella for program management and coordination for the STEM outreach activities of all of the major commands that fall under the purview of ASAALT.

Statement of Task

The Assistant Secretary of the Army for Acquisition, Logistics and Technology (ASAALT) asked Building Engineering and Science Talent (BEST) to conduct an external independent

[1] Dr. John Parmentola, Power Point Briefing on AEOP, September 9, 2005.

review of AEOP. Specifically, the director of Army laboratory research and management tasked BEST to (1) provide a baseline on existing educational outreach program activities; (2) identify measurable goals and metrics associated with these activities; (3) identify beneficial program activities that are not being undertaken within the current AEOP portfolio; (4) identify additional collaborative opportunities within the Army S&T community; and (5) suggest individual or collaborative activities linking AEOP to the outside community.

Scope of Work

The scope of BEST's review involved analyzing profiles of each AEOP program prepared by the program managers, benchmarking each program against design principles of best practice, developing metrics to measure program effectiveness, examining the alignment of Army outreach activities with workforce needs, analyzing opportunities for collaboration, and making recommendations to strengthen and increase the impact of the AEOP portfolio. The framework of analysis and findings of this external evaluation are depicted in Appendix I.

The BEST team engaged in five types of activities to accomplish this effort:

- Reviewed AEOP program information provided by the Army, and researched external and internal sources on AEOP programs and other Army education and outreach activities,

- Interviewed Army S&T leadership, current and former managers of the AEOP programs, program volunteers, laboratory points of contact, program contractors, teachers, students, certain academic partners, and others who play a key role in supporting the AEOP programs,

- Benchmarked AEOP programs against best in class design principles that emerged from BEST's Congressionally-mandated study of program effectiveness and other best practices research,

- Conducted surveys of participants in university-based programs[2], and

- Observed several Army-sponsored internal planning meetings.[3]

More than 125 people were interviewed from December through mid-June, 2006, and members of the BEST team visited eight Army sites.[4] Some interviews were conducted privately with key individuals; others were conducted with small focus groups of knowledgeable employees.

[2] BEST developed a written survey for selected REAP and JSHS sites. These surveys were distributed by the AEOP program manager for REAP and the AAS manager for JSHS. 9 of 54 REAP sites responded; 5 of 5 randomly-selected JSHS sites responded.

[3] These meetings included a GEMS planning meeting at ASAALT headquarters in October 2005, an AEOP meeting at the Aberdeen Proving Ground in December 2005, an HBCU/MI gathering in Huntsville in March 2006, and a MWM off-site meeting in Garrett County Maryland in June 2006.

[4] BEST conducted site visits at: Walter Reed Army Institute of Research (WRAIR); the Army Research Institute (ARI), Arlington, VA; the Army Research Laboratory (ARL) locations at Adelphi and APG; ECBC (Edgewood); the Aviation and Missile Defense Research and Engineering Center (AMRDEC) Huntsville, Alabama; the Engineer Research and Development Center (ERDC), Vicksburg, MS; and the Institute for Creative Technology at the University of Southern California, Los Angeles.

During BEST's site visits and interviews, we used a standard data collection template to solicit information on the AEOP programs in a common format, as well as gather the interviewees' impressions and opinions regarding: the role of STEM education and outreach within their operating unit; the value and importance of AEOP and other STEM education and outreach activities; and their knowledge of, participation in, and support for AEOP and its component programs.

Context for BEST Review

The U.S. Army supports a significant R&D laboratory infrastructure, including more than 20 of its own laboratories, four Army-branded university affiliated research centers (UARCs), and several Army centers of excellence and university-industry collaborative technology alliances (CTAs).

Research taking place within this extended network ranges from high-performance computing, nanotechnology, rotorcraft, advanced materials, bio-mimicry, virtual reality, vehicles, medical, behavioral and social sciences, aerospace, communications and electronics, the environment, and more. Much of this research is among the most advanced in its field worldwide; some in fields perceived as exciting and attractive, even glamorous to many students; and most addressing critical and challenging practical problems. This research enterprise offers a significant training ground for students and potential professionals in many STEM disciplines: bioscience, materials engineering, mechanical engineering, computer science and engineering, aerospace engineering, electronics and electrical engineering, environmental science, medical science, and more.

The Army's Major Commands that are represented within the AEOP framework, and their supporting laboratories, carry out a wide range of both formal and informal STEM education activities. These include: participation in AEOP-branded programs, other career experience programs and internships, summertime student employment, programs to improve science teaching, science outreach programs to K-12 students, sponsorship of student seminars and workshops, hands-on research experiences, a distance science learning program, support for student participation in science and engineering competitions, a summer camp, and assistance with college curriculum development. In addition to this wide variety of programs, there are numerous more informal efforts across the Army S&T community, including judging science fairs, presenting during classroom courses, career days, job shadowing, tutoring in math and science, mentoring at local high schools, and offering laboratory tours.

In short, the Army's distributed science and technology enterprise has the capacity to connect thousands of students of all ages and skill levels: with: real world science, technology and engineering challenges, hands-on learning, training experiences in rich technical environments, and technical professionals in their work settings. Numerous personnel across the Army S&T enterprise are engaged and making diverse and valuable contributions to STEM education and outreach.

I. Baseline of Current AEOP Activities

The AEOP Portfolio

The Army has a long history of support for science, technology, engineering and mathematics (STEM) education and outreach, both in DoD-wide programs, and in programs initiated by the Army. These programs developed on an *ad hoc* basis over many years, and in response to a wide variety of specific needs and interests. As a result, the Army is currently engaged in a rich and diverse set of activities that span the education continuum—from K-12 to graduate-level education and training—and the nation.

Recognizing the strategic importance of greater coordination among these diverse efforts, the Army established the Army Education and Outreach Program (AEOP) in 2004 to bring greater strategic focus, integration and effectiveness to these wide-ranging activities.

The AEOP already has achieved success in a number of important areas that form a strong foundation on which the Army can build:

- Created a corporate brand for the programs currently included in the AEOP portfolio;
- Brought DOD-wide focus and visibility to these efforts;
- Developed a preliminary inventory of the status, outcomes and costs of ongoing education and outreach activities;
- Created a shared web presence for AEOP component programs;
- Led the development of the Human Subjects Protocol to enable the Army to collect and track information on student participants and thereby implement more valuable metrics on effectiveness;
- Simplified the application process for students by developing a unified, web-based application; and
- Tackled program management and implementation issues.

Today, the AEOP portfolio includes five general types of programs: science fairs and competitions; hands-on research and laboratory-based experiences for students of various ages and ability levels; support for classroom-based instruction; internship opportunities for undergraduates, graduates and post-docs; and professional development and laboratory experiences for high school teachers and university faculty. An analysis of individual programs in the AEOP portfolio is at Appendix II.

Specific AEOP-branded programs include:

- ***Science Fairs and Competitions* (JSHS, eCYBERMISSION, ISEF, IMO)*:*** These competition and contest programs—offered for middle and high school level students—are either Army sponsored, or supported by Army funds and/or personnel. eCYBERMISSION, an Army signature initiative, is a virtual science fair that involves thousands of students in "challenge-based" projects and mentoring to demonstrate the role of science and technology in their community and every day life. In *JSHS*, high potential high school students who have completed an original research investigation in the sciences, engineering, or mathematics are invited to apply to regional symposium and vie for awards, including the opportunity to advance to the national symposium. In *IMO*, the Army provides financial support such as for travel expenses to send a team to represent the United States at the International Mathematical Olympiad. The Army offers personnel as judges for the International Science and Engineering Fair, one of the nation's most prestigious science fair competition.

- ***Classroom-based Instruction* (MWM)*:*** The only formal, classroom-based instructional product within the AEOP portfolio, Materials World Modules is a series of twelve-hour interdisciplinary content modules based on topics in materials science and engineering. The modules—designed for use in middle and high school science, technology, and math classes—emphasize inquiry-based, active, hands-on learning. Students of all ability levels use MWM to apply what they learn in the classroom to real-world problems.

- ***Laboratory-based research experiences* (GEMS, SEAP, UNITE, REAP)*:*** These programs provide hands-on research experiences in Army or university laboratories for middle and high school students. The duration of the student experiences varies from a one week to an eight-week experience, as does the degree to which students work side-by-side with scientist/engineer mentors on real Army research projects. These programs also vary in their target audiences, from the high-potential science-oriented students in SEAP, to the socially and economically disadvantaged students in UNITE and REAP who would otherwise not have such laboratory-based experiences available to them.

- ***Undergraduate and Graduate Internships (*CQL, CUWMA, CREST, STARS)*:*** These programs offer undergraduate and graduate level students internship and summer work opportunities in Army laboratories. Students work closely with mentors on hands-on research projects of Army relevance. These programs offer students some compensation in the form of either stipend or pay, and CREST participants qualify for non-competitive appointment in the Army Internship Program. Duration of experiences ranges from eight weeks in CQL to quite significant duration. For example, in CUWMA, Research Fellows may work up to 20 hours per week during the school year and 40 hours per week in the summer, for a maximum of three years.

- ***Professional Development for High School Teachers and University Faculty (*FREP, HSSMFP):** The Army sponsored FREP, administered year round, offers university and college professors opportunities to collaborate with government scientists on short term technical projects at government laboratories. The Army sponsored HSSMFP, also administered year round, provides high-school teachers a hands-on experience in a government laboratory.

These programs have significant reach, engaging more than 150,000 students, nearly 1,400 teachers, and more than 150 universities nationwide in 2004-2005.[5] In addition, Army programs are supported by a pool of enthusiastic and committed volunteers, who are willing to give time and effort to fostering greater STEM interest, education, and skills among students of all ages and skill levels.

The Army's distinctive strengths—a national laboratory network, capacity to offer students opportunities for hands-on science, real-world science and engineering challenges, and a wealth of scientists and engineers to serve as role models, advisors and mentors—create a competitive advantage in the domain of educational outreach, rather than formal classroom instruction. They argue for making investments that will create awareness, spark interest, and connect STEM education to real-world challenges and professionals.

Enhancements to AEOP Goals and Program Criteria

The AEOP's path-breaking effort to develop an integrated STEM education and outreach program portfolio could be refined and enhanced in three key aspects: goals, program criteria and program categories.

❑ Goals

AEOP brings together a diverse group of component programs that developed independently over many years, and in response to a variety of needs and interest. While all programs reflect the Army's commitment to STEM education, the wide-ranging mix of individual program goals diffuses the strategic focus of AEOP and blurs the rationale for investing in educational outreach. Although the AEOP mission statement emphasizes a set of goals for the overall portfolio, many program managers and volunteers tend to view AEOP through the lens of the programs in which they participate.

If the AEOP is to recruit the best and brightest undergraduate and graduate students to careers in Army labs, and contribute to building the nation's science and engineering pool for the "generation-after-next" workforce, the Army should move beyond the diverse collection of goals of the AEOP component programs, and adopt a set of simplified goals that build on the Army's unique competitive advantage in STEM education, support the Army's core research missions, overcome or minimize the challenges of engaging in K-12 education, leverage the Army's scarce financial and volunteer resources, and create a measurable "return on investment" for the Army.

We recommend the following goals be adopted for the AEOP portfolio as a whole:

- Increase the interest and awareness of students from all backgrounds in STEM fields;
- Develop high-potential U.S. talent for careers in science and technology; and
- Attract a fair share of available talent to the Army S&T community.

This narrower goal statement would emphasize the importance of the AEOP portfolio operating

[5] Briefing on AEOP, Dr. John Parmentola, September 9, 2005.

in a more deliberate and integrated pipeline that: begins in K-9 to provide students with STEM career awareness, as well as information and hands-on experiences that excite them about STEM and motivate them to focus on STEM learning. In later years, high school and beyond, AEOP programs should form an explicit pipeline to pull the highest potential students into careers in military-related science, whether they eventually become Army employees, or work on Army-relevant work in academia or contractor organizations. This includes offering more meaningful "hands-on" opportunities in Army laboratories for science-oriented middle and high school students, and developing pipeline programs for older high-achieving, STEM-oriented students that the Army can support, help educate, and groom for potential Army employment.

- **Criteria for Including Programs Within AEOP**

During BEST's site visits and interviews, we learned that many program managers, volunteers, and laboratory managers were often unclear about the rationale for including programs under the AEOP umbrella. The Army should expressly spell out criteria for inclusion of programs within AEOP to increase the transparency, credibility and integration of the portfolio.

BEST recommends the adoption of the following criteria for programs to be included within the AEOP portfolio. These criteria are those that "best in class" STEM education programs have in common. While each AEOP program may not currently satisfy each of these criteria, they will serve as a guide for developing and implementing changes to achieve these characteristics.

Recommended AEOP Program Criteria

1. Goals. Every program will have clearly defined goals that are (1) consistent with AEOP as a whole; (2) fully understood by all program participants; and (3) spelled out in all promotional materials

2. Impact. Every program will have a significant impact in at least one community, or will draw participants from a national base. The determinants of impact will include (1) number of students reached; (2) number of volunteers engaged; and (3) scope, intensity, and duration of the program.

3. Inclusiveness. Every program will embrace students from (1) varying racial and ethnic backgrounds; (2) all income levels; and (3) populations that are historically under-represented in STEM disciplines and careers.

4. Quality. Every program will provide a quality experience to all participants. Such an experience requires (1) challenging content; (2) supportive mentor relationship; (3) recognition of participants as individuals; and (4) a commitment to continuous program improvement.

5. Management. Every program will develop and periodically update a concise management plan linking goals and resources. Program budgets will be routinely submitted to the AEOP management team.

6. Metrics. Every program will collect sufficient data to determine whether its goals are being met. These data will vary by program but will generally include (1) students reached; (2) volunteers engaged and hours committed; (3) costs; and (4) pertinent outcome indicators of interest in STEM, increased skills, continued participation in AEOP programs, and pursuit of STEM careers.

7. Connectivity. Every program will position itself as part of a continuum of AEOP opportunities rather than as a stand-alone intervention. Participants in every program will be routinely alerted to follow-on possibilities.

8. Continuous Improvement: Every program will be made aware of best practices and will demonstrate incremental or other improvements as part of annual evaluations.

9. Communications. Every program will be profiled on the AEOP website, which will serve as the hub for creating an AEOP community.

10. Volunteers: Every program will value and recognize the indispensable contribution of volunteers to effective STEM outreach.

❑ Program Categories

Currently, AEOP programs are organized according to grade levels, rather than as a continuum of opportunities that begins with programs that spark interest, continues with opportunities to develop hands-on knowledge and career awareness, and offers support to sustain engagement in STEM fields through post-secondary education and into the workforce.

BEST recommends that the AEOP adopt the following program categories:

Research Opportunities:

- Hands-on introductory-level laboratory-based research opportunities offered broadly to middle and high school students.

- Advanced research and work experiences in Army laboratories to provide early work experiences and career-oriented training for high-potential high school students, undergraduates and graduate students, with a view to creating an explicit pipeline to draw these students into eventual employment with the Army or its network of academic or contractor partners.

Competitions:

- Inclusive hands-on introductory experiences designed to promote STEM career awareness, and interest and enthusiasm for STEM.

- Advanced opportunities for in-depth science, engineering and mathematics research on real-world problems.

Currently, AEOP programs attempt to address many other worthy goals, for example, providing hands-on research experiences for high school teachers, through the High School Science and Math Faculty Program. However, given the current severe financial constraints on the Army, we think the Army cannot afford to give those programs attention until the essential areas described above are addressed. Therefore, we believe that current AEOP programs that do not support the narrower set of goals and strategy should be given lower priority.

The Army also should embrace programs not currently branded as AEOP programs but which are consistent with AEOP priorities and standards. These include AHPCRC Internship programs, and possibly several programs managed by ERDC, such as the Illinois Minority Pre-College Internship (IMPRINT). In addition, a number of labs have developed ongoing relationships with local schools focused on STEM awareness and Army research, such as Aberdeen's partnership with the local Science and Technology magnet school.

Within each program category—research experiences and competitions—programs and activities should explicitly target different stages of the STEM pipeline, and should incorporate characteristics similar to the following:

Research Opportunities

Inclusive Introductory-level Research Opportunities for Middle and High School Students.

Research programs that typically are most effective for these students should: focus on encouraging students to pursue more advanced STEM studies, let them get a strong exposure to, and some preparation for, STEM career training, and offer the Army the opportunity to identify high potential students for greater attention and development for military science and technology careers. The Army's efforts should focus, as several programs do already, on deeper experiences of greater duration such as hands-on research experiences, work/study, internships, and summer jobs. Mentoring and exposure to role models should also be included. These programs should encourage students to pursue challenging math and science courses in middle and high school that serve as gate-keeping subjects for college level study. GEMS very effectively addresses these issues, and has numerous program attributes nationally recognized as best practices.

Building on GEMS' success, these hands-on research experiences in Army laboratories should be expanded to the extent that resources permit. However, while GEMS is modeled on quality thinking about how to identify science-oriented students and provide experiences to them that move them into higher-levels of STEM learning, GEMS is not the only program model that should be considered for this expansion. GEMS requires a significant amount of management attention, a large group of volunteers, and substantial training and management of volunteers, teachers and near-peer mentors. GEMS has flourished within the culture of WRAIR, but it may be impractical for GEMS to expand rapidly throughout the Army S&T community. Attention also should be given to creating or adopting other quality program models so that lab management will have flexible options from which to choose. Having more options might help the Army expand opportunities for introductory-level research experiences more rapidly.

In all of its awareness and interest activities, as well as for introductory laboratory experiences, it will be vitally important for the Army to draw from a broad and diverse group of students. Research shows that during middle school and high school, student attitudes toward science are more important than their actual performance in science and math schoolwork in determining which students will pursue STEM careers.[6]

The Army should develop and apply standard methods for identifying and reaching science-oriented students in under-represented and/ or socio-economically disadvantaged populations in schools and communities.

Advanced Research and Work Opportunities to Create a STEM Career Pipeline for High Potential Candidates for the Army

To meet the Army's own workforce needs—both internally and in its university and contractor base—as well as to contribute to meeting the national STEM challenge—the Army should identify and connect to high-potential students during their middle school and high school years. These students should be offered increasingly challenging and meaningful hands-on research opportunities throughout high school, and kept meaningfully engaged with the Army STEM

[6] Tai, Liu, Maltese and Fan, University of Virginia, 2006.

enterprise through degree completion, and possible eventual recruitment into STEM positions. The National Security Agency has developed an NSA-oriented pipeline of this type in mathematics and computer science/engineering. *(See Appendix III)*

Creating such a pipeline is especially important for meeting Army STEM recruitment goals since the Army cannot operate in the labor market as effectively and competitively as private employers. For example, the Army has limits on its ability to compete on salary with private employers, but may be able to mitigate that limitation to some degree by building strong and long-term relationships with potential job candidates throughout their education. In addition, by placing these students on an Army STEM career track, laboratory managers may see their participation in their own self-interest—developing future employees that are already oriented toward Army science, technology, and research needs—reducing the pressure currently felt in some locations as a result of trying to balance education and outreach activities with the core mission.

Program attributes include:

- Early identification (high school) of promising candidates;
- Providing information specific to career opportunities with the Army or its academic/ contractor base;
- Direct mentoring by Army staff;
- Continuing opportunities for work/study, internships, and summer jobs with Army laboratories or those supported by the Army throughout the candidate's education;
- Encouraging the candidate to undertake Army- or military-relevant research at the graduate-level;
- A focus on the non-technical skills needed for career success with the employer; and
- Aggressive recruitment at degree completion.

Emphasis should be placed on the areas of greatest workforce need. The Army should use workforce forecasts and analyses previously performed by the Army research enterprise and DOD-wide to inform this effort. Similarly, STEM career training to serve needs beyond those of the Army should be informed by labor market data.[7] Programs focused on STEM career training should also seek relationships with employers to gain information needed to create program content designed to provide participants with skills employers seek.

SCEP and STEP authorities have some particularly attractive features because they enable the Army to hire from the program without the normal government competitive selection process. In addition, the CUWMA contracting model imposes a minimum of bureaucracy, and the authority could easily be expanded to other laboratories.

[7] For example, according to the latest projections from the U.S. Bureau of Labor Statistics for the period 2004-2014, (excluding the social sciences) 74 percent of new jobs in the STEM workforce are forecast to be for information technology workers, and 62 percent of job openings in the STEM workforce (new jobs and net replacements) are projected to be for information technology workers. Thus, if the Army desires to play a role in contributing to the general pool of STEM workers, then programs designed to educate and train computer scientists and engineers would be an important focus. Conversely, degree production in other STEM disciplines—such as physics and biological/biomedical science—are more than adequate to meet the projected demand, and thus may not be as high a priority for the Army's attention.

Other parts of the Army research enterprise, such as, for example, the Materials Center of Excellence, have student internship opportunities built in as natural components of their university research relationships, and are actively hiring students from those programs. A complete understanding of these activities should be developed, and these other programs should be formally embraced as part of AEOP.

Competitions

Research has demonstrated that competitions can be a highly effective means of promoting student enthusiasm for science, math and engineering.[8] In addition, participants in a few national competitions—including the Junior Science and Humanities Symposium and the Intel Science and Engineering Fair—indicated in surveys that their participation did influence their academic and career choices.[9]

Attributes of successful competitions include:

Inclusive Introductory Experiences (Grades 6-9):

- Focus on interest-building and awareness
- Fun, hands-on math and science learning activities
- Demonstrating the link between science and technology and everyday life
- Emphasis on teamwork and collaboration, which is especially effective at engaging girls and students from under-represented groups
- Strong support for students from participating schools and teachers
- Interaction with and exposure to Army scientist and engineer role models
- Age-appropriate career information for students, parents and teachers

Advanced Experiences for High-Potential Students (High School):

- Opportunities for in-depth research and experimentation in science, engineering and mathematics
- Emphasis on real-world, science and engineering-based problem solving
- Strong support for students from participating schools and teachers
- Adequate technical support and mentoring throughout the project
- Interaction with and exposure to Army scientist and engineer role models
- Age-appropriate career information for students, parents and teachers
- Identification of promising candidates
- Recruitment into Army-supported advanced research experiences

[8] Sadler, Cole and Schwartz, Engineering Competitions in the Middle School Classroom, The Journal of the Learning Sciences, 2000.
[9] Somers and Callan, An Examination of Science and Mathematics Competitions, A Report for the National Science Foundation, 1999.

Current AEOP programs—and eCYBERMISSION in particular—already are directed toward the goal of increasing student interest and enthusiasm by providing opportunities for fun, hands-on science activities, focusing on real-world problem solving, and effectively demonstrating the critical connection between science, math and engineering and everyday life. Current activities could be enhanced by showcasing how individual STEM-related innovations and STEM professionals have made profound changes to our world.

Participation in fun, hands-on science and technology activities can also increase student interest in STEM. Young people form opinions about careers before they graduate from high school, and middle school is seen as a key decision-making point. Yet, many students receive little career information. Programs designed to raise student interest in STEM careers should provide information about the wide range of interesting and exciting careers in science and technology, the tangible and intangible rewards of such careers, the industries that develop and use science and technology, what scientists and engineers do on the job, and the education and skills needed to pursue technical jobs.

Exposure to working STEM professionals can help students "imagine" themselves in such jobs. Since parents play one of the most important roles in influencing children's career choices, they need information that enables them to encourage their children to choose a career in science and technology. Teachers and school counselors can also provide such information.

eCYBERMISSION exemplifies many of these attributes, and is well-positioned to become a national leadership program to promote STEM awareness and interest. Already, eCYBERMISSION focuses on daily life challenges to which students can relate. However, eCYBERMISSION must overcome several current constraints on its growth and impact to achieve its full potential. These challenges, and recommended strategies for addressing them, are included in the program review for eCYBERMISSION.

To support an increased focus on providing STEM career information in eCYBERMISSION and AEOP's other inclusive introductory experiences, AEOP could develop "turnkey" career awareness information, and develop a number of compelling stories about how specific innovations and innovators have changed the world in profound ways. This material could specifically include examples of Army careers and Army or military-funded innovations with significant non-military impacts, such as the Internet and GPS. The latter would have the additional benefit of demonstrating the Army's non-warfare role in STEM.

One issue that has not been adequately addressed in academic studies of competitions is the impact of the competition on non-winners. When AEOP conducts its evaluation of eCYBERMISSION—as recommended below—there is a significant opportunity to answer questions that have not been addressed previously, such as whether the competition is positive or negative for non-winners, whether non-winners increase their enthusiasm for science and math, and whether non-winners continue to pursue studies in science and math as they advance through high school and college.

II. AEOP Metrics

AEOP has excelled in developing metrics for program management, including assembling data to compare program costs, improve program efficiency, increase the accountability of managers and allocate scarce resources among programs.

It has proved far more challenging to demonstrate the impact that AEOP programs are having on STEM education outcomes. Currently, a wide variety of metrics are used by the various AEOP programs, such as growth in student participation in a program, enhanced STEM course attendance, improvement in attitude toward STEM, program popularity as demonstrated by student returns and program over-subscription, opinion surveys, degree completion, publication in professional journals, students who persist in pursuing STEM studies, pre- and post testing using the Armed Forces Vocational Aptitude Test, and anecdotal stories. In a number of cases, the link between metrics and stated program goals is not clear. In some cases, program reviews and evaluations are not performed by independent and disinterested parties.

AEOP needs to apply a set of common-sense metrics that are not overly burdensome for program managers and participants, that offer real and comparable measures of program performance, and the cost of which is proportional to program size and emphasis. Our recommendations for metrics for each AEOP program are included in the individual program reviews. In building the evidence base of program effectiveness, AEOP should take full advantage of its visionary human subjects protocol.

The issue of metrics and program evaluation may rise to greater importance. It is unclear as to which, if any, AEOP programs will come under scrutiny of the Academic Competitiveness Council led by Education Secretary Spellings, that aims to develop common metrics to enable comparisons across programs, as well as assessments using scientifically based research. Similarly, it is unclear if AEOP programs will at some point be subject to the Program Assessment Rating Tool (PART) overseen by OMB.

To ensure AEOP success in this environment of heightened scrutiny for government STEM efforts, the Army should invest in formal evaluations for its major programs as resources allow, focusing first on the programs with the greatest visibility, and therefore, exposure. For example, eCYBERMISSION should be a top priority for formal evaluation.

III. Bolstering AEOP Program Activities through Collaboration and Best Practice

The capacity of current AEOP programs to make an increased impact within the Army's existing resource constraints hinges on five main factors: program management, nurturing and supporting volunteers, program connectivity, continuous improvement, and program promotion and dissemination. A discussion of each of these factors follows:

❑ Program Management

Effective program management makes a significant difference in the performance of AEOP programs. A wide variety of management approaches and supporting mechanisms are utilized across the AEOP, ranging from well-resourced professional contract management to dedicated full-time employees or independent contractors working on site and under close direction and control of laboratory management, to "volunteer" managers who run AEOP programs as one of their three full-time jobs. This patchwork of management strategies and structures creates a great deal of tension as volunteer managers struggle to balance their AEOP duties with their core Army mission responsibilities. In addition, tension is also created among programs because the differences in management and funding support create perceptions of unfairness.

ASAALT should seriously consider replacing this patchwork of program management arrangements with a more centralized management structure that allows for greater collaboration, coordination and economies of scale. A competent and adequately resourced AEOP support and coordination unit, whether managed internally, or through a capable external contractor, could enable AEOP to combine the support functions in areas where the programs have common needs, such as security clearances, cutting checks for stipend payments, and numerous program promotion and dissemination functions. The Army could dramatically reduce the burden and redundancy of effort on the individual program managers, particularly those who currently function as volunteers. AEOP also likely could reduce costs by reducing the redundancies in the program-by-program management structure.

❑ Nurturing and Supporting Volunteers

Across Army facilities that participate in AEOP programs, tension arises among management, staff, and AEOP program volunteers over the priority that should be assigned to education and outreach, and the time committed to these activities versus the core laboratory mission. Even when laboratory leadership voices strong support for education and outreach efforts, managers, team leaders and individual supervisors—those closest to the work—may be disinclined to support such activities for fear of negatively affecting the performance of the core laboratory mission.

On the one hand, this is a legitimate concern. Managers and supervisors are held accountable for meeting mission goals, and participation in some AEOP programs represents time and human resource diversion away from the core mission. For example, the recommended time commitment for eCYBERMISSION Ambassadors is 120 hours (or three weeks per year) and, for CyberGuides, more than two weeks in about a five-month timeframe. This is not an insignificant

diversion of time in organizations operating under severe budget and staffing constraints. Many supervisors and volunteers we interviewed told us that they are working harder than ever and juggling multiple responsibilities, and that it is becoming more and more difficult to make time for STEM education activities.

On the other hand, many enthusiastic volunteers make AEOP programs work, and volunteers have a significant impact on their reach and success. In many cases, AEOP programs simply could not operate without them. And often, when there is committed leadership at the directorate level in a laboratory, it appears that a culture of engagement takes hold. This culture is reflected not only in support for AEOP-branded programs, but also for additional and/or local activities, most of which are supported on a shoestring.

AEOP's continued growth—and ultimately, it's long term success—is highly dependent on encouraging larger numbers of scientists and engineers to become volunteers, and taking steps to increase their satisfaction. Currently there are wide variations in policies among Army labs for allowing, supporting and recognizing volunteer work. An Army-wide policy about allowable time for volunteer service (SMDC has such a policy), during and after the regular workday would encourage individual managers to allow individuals to volunteer for AEOP programs, as well as enable their public recognition, something that often is not possible when volunteer work is "under the radar".

Another action is to expand the use of turnkey program information kits to clarify responsibilities, expectations and where to look for advice and support. For example, eCYBERMISSION offers standard kits that provide detailed instructions for program personnel and volunteers, such as Ambassadors and CyberGuides, on how to carry out their work in support of the program.

- **Connectivity among Programs to Provide Education and Career Pathways**

The vision of AEOP has always included providing more than a one time learning experience. Linking program opportunities along the educational continuum will deliver greater value to individual students, tie component programs more closely together, and make it easier for the Army to sustain student engagement in STEM and potential interest in Army research careers.

The GEMS-SEAP-CQL progression is a nascent pipeline approach for the most competitive students, and provides a solid foundation on which AEOP can build to create additional pathways for students. Currently there is a gap in program options for students in grades 8-12: successful eCYBERMISSION and GEMS students who wish to pursue more challenging opportunities have very limited options if they cannot achieve competitive entry into SEAP or one of the higher education internship programs.

AEOP could take four steps to help create these pathways. First, create opportunities for additional middle and high school students to become involved in introductory lab experiences, through a combination of a continued expansion of GEMS, other lab-based programs already within the Army, such as AHPCRC internships, or creating new program mechanisms. For example, the Army could use the SEAP authority to create a non-competitive hands-on research and mentoring program for many students who succeed in GEMS and eCYBERMISSION.

Second, AEOP could simplify, and make its college-level program options more user friendly. The existence of a number of local, federal, DOD and other internship programs for undergraduate and graduate students across the Army S&T community – including CQL, CUWMA, CREST, STARS and WISP - creates a confusing patchwork. There is a toolbox of flexible mechanisms available to the Army—including authorities under SEAP, CUWMA's simplified contracting processes, STEP and SCEP—that provide the option of combining the best features of all of these programs into a single, simple to use internship authority.

This authority can then be customized to meet the needs of each Army laboratory, and the diverse needs and interests of individual mentors and students. If a mentor and student wish to establish a longer summer experience than the 8 weeks permitted by SEAP, there should be flexible mechanisms in place which will allow that to occur. Or, a high-school senior may seek a summer internship prior to college, while a college sophomore or junior may find a school/work rotation scheme desirable. Similarly, lab sponsors may have a variety of needs or capabilities that allow participation at certain levels or at certain times. A flexible authority would allow them to meet these constraints.

Third, the AEOP web site content could be expanded to increase students' awareness of opportunities to bridge to the next level, and AEOP could regularly disseminate program information by email to all students with an AEOP connection, as well as sponsoring teachers and schools.

Finally, AEOP could strengthen ties between the Army and the high-level competitions in which it participates: JSHS and ISEF. Currently, students receive minimal exposure to Army scientists and engineers, and virtually no information regarding career opportunities in military science. Because these students are highly talented and motivated, and many pursue advanced degrees in STEM, efforts should be made to establish a strong and continuing connection with them, and to recruit them into advanced research experiences with the Army.

- **Continuous Improvement**

A hallmark of the nation's most effective STEM education programs is their ability to learn from their own experience and from others. By sharing knowledge and information across programs, and using the lessons learned from programs recognized as best-practice nationwide, AEOP could align its programs with best practice by developing modules of content that could be shared across programs. These elements might include:

Exposure to Work of the Army. During the BEST site visits, Army leaders stated a desire to expose students to the Army's S&T mission, and we believe that exposure is vitally important if the AEOP programs are to make a contribution to filling the Army's talent pipeline. However, there is currently a wide variation in program duration and exposure to the work of the Army.

For example, programs that involve students in internships for one or more summers are likely to have lasting effects and, if they take place in Army labs, they are likely to impart significant positive exposure to the Army's non-warfare role. Other programs are very short in duration or take place outside Army facilities and, thus, participants have less exposure and less time to

develop knowledge and positive views of the Army's non-warfare role. In some cases, a program's link to the Army is so tangential that there may be little or no effect on student attitudes about the Army, or students may be unaware of the Army's program sponsorship.

Programs that have a high degree of touch by the Army should be given priority over those with a weaker connection to Army scientists and engineers. BEST believes that programs in which the Army currently pays outsiders to provide awareness and lab experiences to students are less valuable to both the Army and the students than programs that provide students hands-on experiences in Army laboratories.

Mentoring. Mentoring—considered a best practice in teaching STEM students and developing STEM professionals—is an element of many AEOP programs, although the intensity of mentoring varies by program. For example, in some programs, summer interns are mentored closely and daily. In eCYBERMISSION, mentoring is "on call" during certain periods of the day, but limited in its duration. In most of the AEOP internship programs for high school students, undergraduates and graduate students (SEAP, CQL, CUWMA, CREST), some care is taken in matching students with mentors, and mentor/protégé' relationships are then left to develop naturally.

While this informal mentoring system seems to be working well at many locations, if the Army wishes to encourage more scientists and engineers to become mentors, it may want to take steps to make more people prepared to be good mentors. AEOP may want to consider developing a core body of informed knowledge that can be shared among program mentors to help encourage others to mentor, and help those who may not be naturally as comfortable in these relationships. In addition, the Army should consider sponsoring periodic mentoring workshops, where mentoring experts could provide Army mentors and potential Army mentors with information and advice on the best informal mentoring techniques. This might serve to reduce the knowledge barrier to increasing the number of volunteer mentors.

Drawing from a Diverse Talent Pool: Increasing the number of students entering the STEM education pipeline requires engaging those who would otherwise choose a different path, or who may not have demonstrated a STEM orientation. For many students—particularly women, under-represented minorities and economically disadvantaged students—this requires early intervention, and often support to students throughout high school to ensure that they pursue the advanced science and math courses that are necessary to enable them to pursue science and engineering at the undergraduate level.

For example, research shows that women graduate from high school equally prepared to enter STEM fields, but typically do not choose to participate in STEM fields at a rate that is equal to their participation in higher education or the workforce. This suggests that increasing women's participation in science and engineering jobs requires efforts to get more college-bound women to choose these fields of study. Mentoring, summer jobs, internships, and scholarship support offer incentives for women to pursue STEM education. In addition, offering a variety of support during the undergraduate years can increase women's persistence in STEM studies. For example, Dartmouth University's Women in Science Project, in which ERDC's Cold Regions Research and Engineering Laboratory is the largest off-campus participant, established

supportive intervention strategies include mentoring, early hands-on research internship experiences, role modeling, access to special information programs and communications, and building a sense of community among the students.

Different strategies are needed for students from African American, Hispanic and Native American populations. Students from these groups who earn bachelor's degrees earn them in science and engineering disciplines at rates equal to white students. This suggests that the principal way to improve the participation rates of under-represented minority populations in science and engineering is to increase their presence in the overall pool of undergraduate students. This means that interventions must take place at the elementary and especially secondary school levels. GEMS' focus on identifying "science-enthusiastic" students from under-performing school systems, and emphasis on communicating to those students the value and importance of achieving a college degree, is a good example of a positive intervention of this nature. Although apparently not part of the formal GEMS evaluation, GEMS is able to point to a number of students who were the first in their family to go to college.

- **Program Promotion and Dissemination**

Due to its sprawling and diverse nature, it is challenging for Army staff, teachers, and students to gain a clear picture of the scope of opportunities within the Army's STEM education and outreach enterprise. The Army should take a number of concrete action steps to improve program dissemination processes:

Continued Web Site Development. The launching of a single AEOP web portal was an important step in presenting the fuller picture, and a universal application will make it easier for participants to apply for AEOP programs. However, web site navigation could be improved with a refocus on the customer—students, parents, teachers—such as offering a separate navigation scheme for each of these customers that leads them to information tailored to their needs. In addition, the web site design lacks the look, feel, and excitement that today's tech-savvy students have grown accustomed to through their video gaming and multi-media experiences.

AEOP should continue to develop this web portal into a user-friendly "one stop shop" for Army STEM education and outreach opportunities. This includes offering comprehensive information, allowing navigation tailored to the user, giving users the ability to identify activities/opportunities in their geographic area, and enhancing the web site's visual, multi-media, and interactive features to make it more attractive to today's students. In addition, the agency and lab-level web sites should either be redeveloped in the model of the AEOP "brand" or simply offer a link to AEOP's main site.

Greater Collaboration in Program Promotion. Currently, each AEOP-branded program develops and disseminates its own program marketing material. This approach fails to take advantage of all of the channels of communications programs have developed in order to promote all AEOP programs. AEOP should develop "branded" material with a similar look and feel for all of its student programs and have each program disseminate material on all of the programs. As discussed in Section V below, this material should also be disseminated through the National Science Teachers Association and other appropriate national-level communications mechanisms.

Developing Alternatives to retail promotion activities. Significant resources are devoted to one-on-one outreach to individual teachers, schools and families. This "retail" approach is expensive and time-consuming, takes significant time to reach critical mass, and alone will not take AEOP to the next level. Other outreach methods may be more effectively deployed. This includes promoting programs to national-level organizations that can reach more educators, or reaching out to state or school district-wide decision-makers.

One reason retail approaches are expensive and time consuming is fragmentation of the education system, with 16,000 school districts to which the Army could market AEOP programs. This fragmented market leaves the Army with the time consuming task of promoting AEOP to individual schools and many smaller markets, or attempting to place the product in one or more large adoption states (such as California or New York). In addition, the Army lacks the extensive marketing channels to promote its products to schools broadly, as well as the funding for significant evaluation studies to demonstrate the educational efficacy that the conservative K-12 market is looking for.

Using one of its programs as a test case—for example MWM or eCYBERMISSION—the Army may wish to consider entering the adoption processes of one or more of the large adoption states mentioned above, or seek a partnership with a commercial education materials publisher that has the wherewithal to promote AEOP products more broadly.

IV. Identify Collaborative Opportunities within the Army S&T Community

Three main targets of opportunity stand out for closer cooperation and collaboration among activities within AEOP, each of which needs an individually tailored strategy:

- Increase participation of the Corps of Engineers
- Tap the outreach capabilities of academic partners
- Build closer ties to minority-serving institutions

Tap the STEM Outreach of the Corps of Engineers

Many Corps of Engineers locations participate in varied programs within their local area. Some programs are managed and funded by other organizations, such as the WISP at Dartmouth to which CRREL provides resources. Others have been developed and are jointly managed by local universities or schools and COE labs. Although two locations participate in SEAP – the ERDC Topographic Engineering Center and the CRREL in New Hampshire – there is little evidence that the majority of ERDC locations are aware of AEOP and its component programs. Further, in Vicksburg and Champaign-Urbana, there are quite a few programs of long duration that have significant volunteer participation by the lab personnel.

However beneficial these programs are, there are two immediate actions that could reinforce their value and potentially expand their reach. One is to encourage ERDC to align its decentralized outreach program; the second is to ensure that ERDC personnel are aware of the opportunities within the AEOP portfolio. Given the widespread and diverse aspects of the Corps of Engineers, designating ERDC as the AEOP lead and establishing an AEOP point of contact in Vicksburg would provide an efficient way to begin mutual awareness and cooperation.

Tap the Outreach Capabilities of Academic Partners

The Army's diverse set of R&D facilities—both Army and Army-affiliated academic laboratories—offers a significant opportunity for contributions to STEM education and workforce development. One of the most important features this extended government/academic/industry research enterprise offers for attracting and developing new STEM talent is the focus on Army needs, rather than STEM research for the future that may or may not directly support Army needs.

The academic research centers the Army supports could play a larger role in training individuals to fill the Army's STEM pipeline, if their education and outreach activities were aligned with the AEOP pipeline strategy.Training STEM students who may later perform goal and needs-oriented research is especially important for those who will eventually work for the Army itself, in the Army's contractor base, or in industry (where most scientists and engineers will work).

The Army provides significant funding to university partners through the UARCs, Centers of Excellence, and CTAs and, as such, AEOP in partnership with ASAALT, has the leverage to encourage a greater focus on education within these laboratories as well. In encouraging an

increased focus on STEM education, the Army's should emphasize the priority it places on using its research funds to develop its own STEM pipeline. These academic centers may require funds specifically designated for education and outreach. Further, in a number of cases, these institutions were unaware of the variety of AEOP programs that are available. [10]

Additional participation may be encouraged by formally considering the role of education in decisions concerning R&D funding for participating universities. The National Science Foundation has done just that, by requiring that grant proposals address how they will contribute to teaching, training, and learning

Similarly, when the Army Research Laboratory issued its request for proposals to establish a Center of Excellence in Materials Research, it built into its request requirements for a strong educational component. The collaborative agreements executed with each participating university allowed the Materials Center to build in funding to support 8-10 graduate and post-doctoral students each year, working under the supervision of at least one Army researcher who is a co-investigator or partner. In addition, sufficient funding is included for an additional 10 undergraduate summer internships in Army laboratories (although some students work in their university labs).

The UARCs, Centers of Excellence, and CTAs that participate in education outreach programs focus primarily on early career training for undergraduate and graduate students, including participation in flexible internships and work-study programs. Some of the academic institutions participating in these programs already are engaged in a rich variety of activities, such as the Institute for Creative Technologies (ICT) at the University of Southern California. ICT offers to college juniors, seniors, and graduate students who are pursuing technical studies the opportunity for interdisciplinary internships to prepare for careers in simulation and virtual reality fields. Students work a full-time, 40 hours per week schedule. Depending on the student's home university, course credit may be received for the internship work at ICT. Students like these are likely to be excellent candidates for AEOP-branded internships in Army laboratories.

It is not clear the degree to which of the other Centers of Excellence, UARCs or CTAs have built-in mechanisms to support student internships. Establishing an AEOP POC at all UARCs and selected other academic partners can pave the way for greater awareness of options. In addition, adding mechanisms such as those used by NSF or the Center of Excellence in Materials Research as current agreements are renewed or new agreements are created will make a significant difference in STEM education outreach.

Build Closer, More Productive Ties to HBCU/MIs

The Army supports several generic programs as part of its outreach and partnership efforts with HBCU/MIs; although individual labs have a variety of relationships with HBCU/MIs within geographic proximity. The formal programs include "seminar" opportunities for Army ARL and HBCU/MI administrators to exchange information about their work and capabilities, such as a

[10] Developing a comprehensive understanding of the STEM education and outreach efforts within the UARCs, Centers of Excellence and CTAs was beyond the scope of BEST's tasking. Our information is based on a single site visit, some information research, and brief telephone interviews with program managers for a handful of centers.

meeting hosted by AMRDEC and six HBCU/MIs to explore potential cooperative agreements. Also, the Army High Performance Computing Center hosts an Advanced Summer Institute on six university campuses, four of which are HBUC/MIs. These programs are funded by the Army using 10% HBCU/MI "set aside" funds.

The majority of informal education activities between HBCU/MIs and Army labs or organizations derive from geographical proximity. It is not unusual to find a mixed record of satisfaction on both sides over time; such as the student/scientist exchanges and internships between ERDC in Illinois and Haskell University. The closeness of the locations, however, encourages continued efforts to work together. In the case of formal education cooperative agreements, geographical proximity also tends to be the norm; although many of the labs look at a wide region, such as AMRDEC in Huntsville, which works with colleges and universities in a number of southeastern states.

Presently, ERDC has active educational partnership agreements with eight of HBCU/MIs, that offer a range of activities including student employment, assistance in accreditation activities, co-authoring papers with faculty members, collaborates on some pertinent research, presents class lectures and seminars, etc. These activities are important for building STEM research and education capacity in these institutions; although there is no ERDC strategy that builds on or makes use of the local impact of these programs. One of the few programs that appears to "connect the dots" is the ERDC pipeline to University of Puerto Rico Mayaguez, which seems to supply students to Champagne Urbana as well as the Vicksburg labs.

The majority or these relationships are represented by individuals within labs and universities who choose to develop cooperative activity for student and institutional development; they are rarely institutional relationships and therefore tend to lapse when the individual leaves.

A more strategic approach would serve AEOP and individual labs and other installations better. Such an approach would require some information gathering to learn about HBCU/MIs in locations remote from labs; a review of partnership agreements with HBCUs/MIs to incorporate best practices and set realistic expectations for the labs and the universities; and increasing awareness of AEOP opportunities at HBCUs/MIs in which the Army has invested. In addition, AEOP should expand ties with Hispanic serving institutions that have subject-matter expertise in areas of interest to the Army.

V. Opportunities to collaborate with the external STEM outreach community

AEOP activities do not take place in a vacuum, but against a backdrop of a wide array of local, regional and national STEM education initiatives. There is, however, little awareness of AEOP programs by organizations outside of the Army and little awareness within AEOP about the rich and diverse portfolio of activities among the STEM education and research community.

Most of these external activities are managed and funded by government, non-profit and corporate stakeholders. Many are membership organizations for teachers and professionals in STEM from K-12 through universities and research institutions, as well as organizations that serve as networks and resources for minorities and other under-represented groups.

Membership organizations typically provide a wide variety of resources to their members and information to the public, including links to materials and curriculum; information about programs for use by teachers, parents and students, networking opportunities online or during conferences. Because their members look to these organizations for help and support, they provide an excellent opportunity for the Army to reach individual teachers and schools on a national level. Links to organization websites, promotions at conferences, inclusion in the list of resources for particular grades, mentions in newsletters, and other options are of particular value to recently-established programs such as eCYBERMISSION and GEMS.

Successful outreach to individual teachers also can lead to increasingly rapid awareness of and participation in AEOP programs as larger numbers of teachers are involved in the "word of mouth" that is so important within the K-12 community. By providing information to larger numbers of teachers about these options via their associations, AEOP also can broaden the pool of students eligible for participation in AEOP programs, given that these students typically must be recommended by teachers.

Other organizations can assist in reaching out to audiences of particular interest to AEOP. These include the Association for Women in Science, the Girl Scouts, National Action Council for Minorities in Engineering, National Association of Multicultural Engineering Program Advocates, Society of Hispanic Professional Engineers, Society of Mexican American Engineers and Scientists, and others.

There also are opportunities to collaborate with programs managed by other organizations on a local level. Some Army locations already participate in this type of cooperative work, such as the CRREL's support to the Dartmouth University site for Women in Science Professions (WISP) program and the Edgewood lab use of the American Chemical Society's "Chemistry in the Classroom" program.

A first step in developing the relationships with these kinds of organizations is a simple introduce by AEOP to targeted organizations, most of which are in the Washington, DC. An initial set of target organizations includes:

- *Society of American Military Engineers* (Alexandria, VA)
- *Association for Women in Science* (Washington, DC)

- *National Society of Black Engineers* (Alexandria, VA)
- *American Indian Science and Engineering Society* (Albuquerque, NM)
- *Society of Professional Hispanic Engineers* (Los Angeles, CA)
- *American Chemical Society* (Washington, DC)
- *National Science Teachers Association* (Arlington, VA)
- *National Council of Teachers of Mathematics* (Reston, VA)
- *American Society for Engineering Education* (Washington, DC)
- *National Alliance of State Science and Mathematics Coalitions (*Arlington, VA)
- *National Action Council for Minorities in Engineering (*White Plains, NY)

In order to reinforce and expand the impact of AEOP, as well as to develop a stronger evidence base for program ROI, AEOP should consider establishing an advisory group, comprised of leading practitioners, researchers, and policy makers. Such a group also could serve as a vehicle to raise the Army's profile within the STEM education community. A first step in moving forward on this recommendation would include some initial discussion with the Army sites that already partner with such organizations, as well as developing a short list of organizations to approach.

Appendix I: Framework of Analysis

GOALS

AEOP Portfolio:

- Increase the interest and awareness of students from all backgrounds in STEM fields;
- Develop high-potential U.S. talent for careers in science and technology;
- Attract a fair share of available talent to the Army S&T community.

Individual AEOP Programs:

Recommended goals for each of the individual AEOP programs are included in the program review section of the report.

PROGRAM CATEGORIES

RESEARCH OPPORTUNITIES

Inclusive Introductory Research Opportunities (Grades 8-12):

- Materials World Modules (MWM)
- Gains in the Education of Math and Science (GEMS)
- Army High Performance Computing Research Center (AHPCRC) Internships
- Internship Science and Engineering Program (ISEP) (CERL)
- Uninitiates' Introduction to Engineering (UNITE)
- Research and Engineering Apprentice Program (REAP)

Advanced Research Opportunities for High-Potential Students (Grade 11-Higher Ed):

- Science and Engineering Apprentice Program (SEAP)
- College Qualified Leaders (CQL)
- Consortium of Universities of the Washington Metropolitan Area (CUWMA)
- Career-related Experience in Science and Technology (CREST)
- Women in Science Program (WISP)
- AHPCRC Internships
- Student Career Experience Program/Student Temporary Employment Program
- Army Intern Program
- Summer Research Opportunities Program (SROP) (CERL)

COMPETITIONS

Inclusive Introductory Experiences (Grades 6-9):

- eCYBERMISSION
- Local Science Fairs and Competitions

Advanced Experiences for High-Potential Students (High School):

- Junior Science and Humanities Symposia (JSHS)
- Intel International Science and Engineering Fair (ISEF)

- International Mathematics Olympiad (IMO)

KEY PROGRAM COMPONENTS IN EACH CATEGORY

RESEARCH OPPORTUNITIES

Inclusive Introductory Research Opportunities (8-12):

- Fun, hands-on research experiences, becoming deeper and progressively more challenging as students move through each year of high school
- Demonstrating link between science and technology and every day life
- Interaction with and exposure to Army scientist and engineer role models
- Individual and group mentoring
- Encouragement to pursue advanced math and science in high school
- Encouragement to attend college
- Age-appropriate career information for students, parents and teachers

Advanced Research Opportunities for High-Potential Students (11-Higher Ed):

- Early identification of promising candidates
- Direct mentoring by Army scientists and engineers
- Continuing opportunities for work/study, internships and summer jobs with Army laboratories or those supported by the Army throughout the candidate's education
- Providing information specific to career opportunities with the Army or its contractors
- Encouraging candidates to undertake Army or military-relevant research at the graduate level
- A focus on non-technical skills needed for career success
- Aggressive recruitment at degree completion

COMPETITIONS

Inclusive Introductory Experiences (Grades 6-9):

- Focus on interest-building and awareness
- Fun, hands-on math and science learning activities
- Demonstrating link between science and technology and every day life
- Emphasis on teamwork and collaboration
- Strong support for students from participating schools and teachers
- Interaction with and exposure to Army scientist and engineer role models
- Age-appropriate career information for students, parents and teachers

Advanced Experiences for High-Potential Students (High School):

- Opportunities for in-depth research and experimentation in science, engineering and mathematics
- Emphasis on real-world, science and engineering-based problem solving
- Strong support from participating teachers and schools
- Adequate technical support and mentoring throughout the project
- Interaction with and exposure to Army scientist and engineer role models
- Age-appropriate career information for students, parents and teachers
- Identification of promising candidates
- Recruitment into Army-supported advanced research experiences

METRICS

Overall AEOP Portfolio:

- Number of AEOP students pursuing advanced math and science in high school
- Number of AEOP students who return to AEOP programs each year or progress from one AEOP program to another
- Student attitudes toward math and science based on pre and post-tests
- Level of interest in military science careers, based on pre and post-tests
- Number of AEOP students who enter college
- Number of AEOP students who select science and engineering majors in college
- Number of AEOP students who complete undergraduate science or engineering degrees
- Number of AEOP students who become Army employees, or pursue military science careers
- Number of AEOP students who enter public service

Individual AEOP Programs:

Recommended goals for each of the individual AEOP programs are included in the program review section of the report.

Appendix II: Analysis of Individual AEOP Programs

Grades 6-9

ECYBERMISSION

High School

GEMS

IMO

ISEF

JSHS

REAP

UNITE

High School/Higher Education

AHPCRC

CUWMA

CREST

SEAP/CQL

STARS

WISP

Teachers

MWM

FREP

HSSMFP

eCYBERMISSION

❑ Program Overview

Date established: 2002

Lead Army Organization: Army Research Laboratory

Management Structure: Oversight by a full-time Army employee, with full administrative and program management support outsourced to Booz Allen Hamilton.

Participating Organizations/Locations:
ASAALT
Army Research Lab (ARL), Adelphi, MD and Aberdeen Providing Ground, MD
Aviation & Missile Research, Development, & Engineering Center (AMRDEC), Huntsville, AL
Consortium Universities of the Metropolitan Washington Area (CUMWA), Arlington, VA
Space Missile Defense Command
Army Material Command
Medical Research and Material Command
Corps of Engineers

Annual Budget:
2004/05: $4.378M total:
Awards - $2.575M
Administrative - $1.724M

Target student population:
- 6th-9th grade students nationwide, U.S. territories, and DODEA schools.
- eCYBERMISSION seeks a diverse group of participants with a wide range of proficiency levels, interests and backgrounds.

Student selection:
- On-line registration by 3 or 4-person student teams, with team advisor (teacher, other qualified school advisor and/or parent). Formal application must fulfill the requirements and format of the "Mission Folder".
- Winners are selected by qualified volunteer judges reviewing online.

Number of Students Served:
2003/04: 4148
2004/05: 7960 [# teams: 1900 registered; 1151 completed entries]
2005/06[11]: 4035 [# teams: 1,602 teams registered; 1111 completed entries]
(Army program manager and contractor suggested that the decline in 2005/06: from states w/ high number troop deployments)

Number of Participating Teachers:
2003/04:512
2004/05: 517

Administrative Cost per student:
2003/04: $550
2004/05: $216

[11] 2005/06 data from contractor's press release

Growth Trajectory: The substantial commitment of resources and high level of engagement by the Army would suggest more rapid growth in eCybermission than is the case. In reality, the twin challenges of engaging teachers' attention and time and of finding sufficient numbers of Army volunteers have been and will continue to constrain rapid growth. To the degree that the program becomes well-recognized nationally and on the state level, that recognition may serve to drive local interest from schools and school districts.

❑ **Brief Program Description:**

eCybermission is a web-based science, math, and technology competition that fosters collaborative learning through a team format, on-site discussion forums, and access to an array of resources, including online "eCyber mentors". Students work in teams of 3-4 students in the same grade, mentored by an adult supervisor (usually a teacher) to identify and solve challenges in their communities. By applying science to a problem affecting the community, students not only discover the applications and relevance of science, math and technology but also realize how they can make a difference in their communities.

Students compete in one of 4 regions, with 2 overall awards per region, per grade, including $3,000 savings bonds for each, and travel costs to National Judging and Educational Event for the 1st place winners. In addition, each region makes 4 Criteria Awards per grade of $2,000 savings bonds per student winner.

The 1st place regional finalists compete in Washington, D.C. for the National Awards, with a 1st place winning team in each grade. These students receive a $5,000 savings Bond, medal and plaque. The other National Finalists (3 per grade) receive $3,500 savings bonds and medal.

Army volunteers serve as Ambassadors (promote program through outreach to schools and teachers); Guides (online mentors and resource for students); and installation POCs. Judges (who may be either DOD employees or from private sector) review each application according to established criteria.

❑ **Program Goals and Objectives**

- Established in response to a call by General Shinseki for a "Science Fair for the Nation", to address the national decline in science and math scores among students by:
  - ♦ Increasing interest in science, math and technology among middle and high school students.
  - ♦ Raising the visibility of the Army as leaders in science, math and technology.
  - ♦ Being a premier and inclusive forum for learning.
  - ♦ Broadening participation beyond conventional science competitions.
  - ♦ Leveraging human resources to ensure a successful outcome.
  - ♦ Ensuring basic competition framework that can be sustained over time.
  - ♦ Meeting the increasing math and science staffing demands of a global market.
- eCYBERMISSION fosters collaborative learning through onsite discussion forums and access to an array of resources.
- eCYBERMISSION promotes the importance of real life applications of science, math and technology through several "themed Mission Challenges" to solve problems in their community.

❑ **Program Promotion Methods and Responsibility:**

The contractor, Booz, Allen Hamilton provides extensive materials, training and support for Ambassadors and

Installation POCs and for CyberGuides, including a Welcome KIT with turnkey program materials for each volunteer responsibility. The contractor also promotes the program to external and internal audiences via:
press releases/media advisories and articles to Army, educational and general media; media coverage of road-show events and the National Judging and Educational Event; promotional and print materials to reinforce brand; targeted web and print advertising.

Installations/Commands: Volunteer Ambassadors initiate connection/engagement to schools via: local dissemination/communication with school district offices, principals, teachers, parents; direct marketing/mailing to teachers; attendance at educational conferences; direct outreach to individual schools, school districts.

AEOP provides passive promotion via the eCybermission website and the AEOP website.

- **Data/Outcomes/Other metrics:**

Formal or informal evaluation:

The contractor develops annual report derived from online attitude surveys of Army volunteers, and website "suggestion box" for students, teachers/advisors.

Current program metrics:
- Growth in student participation.
  During the 2005 competition year, there was at least one team from each state and territory.
- One of the challenges in developing satisfaction and impact metrics has been the limitation on collecting and tracking student data. The contractor offers an online "suggestion box" on the internal eCybermission website for teachers and students, but the response rate in 2005/06 was minimal – just 4% of students and 9% of teachers.

Qualitative metrics:
- Anecdotal information from contractor indicates that a relatively high number of teachers have returned as advisors for a 2nd year, which would indicate they found value for their students in the experience.
- Anecdotal information also suggests that parents of the winning students also are very engaged, and very excited at the opportunities their children are getting through eCYBERMISSION.

- **Strengths and Challenges**

eCYBERMISSION's great strength is its ability to connect students to the role science plays in meeting real-world challenges in their communities and to do so in the web-based, interactive format that aligns with the habits and expectations of today's students.
It offers the challenge and opportunity to the students in developing abilities and experience in creative research, scientific inquiry, and collaborative learning.

Content:
The choice of one of four "themes" demands that students focus on pressing issues and the need for the team itself to choose a topic requires research and evaluation by the group. The team-based format requires collaborative learning and the use of web-based resources. The content is said to correlate with science standards for middle school, but this information is not available on public website and the contractor was reluctant to offer "fake" registration).

The outcomes are clearly defined and stated, and the judges use the questions in the student team applications as the template for judging. The content is challenging, as is the process of developing an application. The application's emphases are on scientific thinking and processes.

Engagement, Personalization and Commitment:
The program is structured to provide students with access to mentors and experts, but the limited or no data that the program is allowed to collect makes it difficult to gauge the actual success of this option. First and foremost, there is

no data or information available about the interactions between teams and their teacher/advisors. Second, there is no data and only anecdotal information available about the type and value of online interactions between students and the Cyberguides. It also is not clear whether students like and/or use Cyberguides and/or the eCybermission website chat and schedule "seminar" features.

Further, while Cyberguides are meant to be available to students during the day and evening, in 2004/05, only 18 Army volunteer Cyberguides were available and in 2005/06, only 59 – for an estimated need of 75 in each year. Low volunteer response in 2005/06 suggests either or both: lack of awareness of program, lack of local leadership support, lack of volunteer interest or overly demanding time commitment. There also have been suggestions that the wartime footing of the Army limits the availability of volunteers.

A significant barrier to rapid expansion and ultimate success of the program as a "science fair for the nation" is the dependence on Army volunteer "Ambassadors" to contact teachers and schools (often with little knowledge of either); and on skilled teachers who have the capacity to motivate/advise team projects and who are willing and able to commit the necessary time to the project. Successful outreach to the schools and teachers depends on relationship building over time and on word of mouth among teachers; yet Army volunteers often change yearly.

Dosage/Duration: While the final competition and awards ceremony is well attended by top Army leadership and is highly branded, the success in branding it on the local level is far from the case, not only in terms of public awareness but in terms of Army buy in.

❑ Program Recommendations

Expand national promotion and awareness.
Responses to BEST interviews suggest that neither Army labs nor school principals and teachers are aware of or understand the "value proposition" of eCYBERMISSION. This is a particularly significant hurdle because of the time commitment for volunteers and for teachers. It is also the case that the relatively new eCYBERMISSION program must compete for time with local and/or well-established K-12 science programs. Teachers view it as add-on project; although it is set up to integrate with science standards, this information is not available until after a teacher registers.

Develop opportunities (possibly via the website or eCyberguides), for communication with all eCybermission students in order to:
- Provide feedback to non-winning students and their teacher-advisors;
- Inform students about Army and other program opportunities;
- Add opportunities to connect non-winning but interested eCYBERMISSION students to introductory lab experiences to the extent possible, given geographic and capacity limitations.

Add additional information to the Army volunteer "welcome" kit and to the website:
- Information about the structure and operation of schools and school districts;
- Information that defines eCybermission's "value proposition" from perspective of schools
- Improve accessibility to all of the website's information, instead of providing much of the information only after a teacher has registered.

Benchmark eCybermission against the Internet Science and Technology Fair. This is a longer-established program, with similar attributes and goals to eCYBERMISSION. http://istf.ucf.edu/

❑ Recommended Goals

Create national brand for eCybermission

Streamline volunteer requirements across Ambassadors and Cyberguides.

- **Recommended Metrics**

  - Student attitudes toward eCYBERMISSION experience, based on online pre and post-tests.
  - Student attitudes toward science and math based on pre and post-tests.
  - Increase in student awareness of the role science plays in solving real-world challenges.
  - Number of students returning to the eCYBERMISSION program for multiple years.
  - Number of students moving from eCYBERMISSION into other science interest and awareness activities.
  - Participating schools re: number of years participating; location; number of teachers/teams in school.

The Intel International Science and Engineering Fair (ISEF)

❑ Program Overview

Date established: Founded by Science Service (nonprofit organization in 1950, with Intel as sponsor. Army participation began 1960s

Lead Army Organization: ARO/Youth Science Programs

Management Structure: Oversight by Army personnel.

Participating Organizations/Locations: There are about 475 science fairs; the Army participates in ~325.

Annual Budget: There is a fee per judge for participation. No information available on the amount or on number of Army judges.

Target student population: 9^{th}-12^{th} grade students.

Student selection: Each student must first compete in an "affiliated fair" that must consist of five participating high schools or 50 students in the 9th-12th grades. Each affiliated fair can then send two individual project finalists and one team project to compete in the Intel ISEF.

Number of Students Served: in 2006, the Army presented 20+ awards on the state and regional levels.

Cost Per Student: N/A

❑ Brief Program Description:

The Intel International Science and Engineering Fair (Intel ISEF) is the world's largest pre-college celebration of science. Held annually in May, the Intel ISEF brings together nearly 1,500 students from more than 40 nations to compete for scholarships, tuition grants, internships, scientific field trips and the grand prize: a $50,000 college scholarship.

Science Service, a non-profit organization based in Washington, DC, founded the ISEF in 1950 and is very proud to have Intel as the title sponsor of this prestigious, international competition. Science Service's mission is to advance public understanding and appreciation of science among people of all ages through publications and educational programs. Science Service has encouraged students, parents, teachers, and communities to explore the vast world of science.

The Army participates by providing judges on to science fairs in various locations. The Army assists in identifying judges (must have PhD. or equivalent experience in particular subject area) within particular location and pays a fee to participate in the affiliated fair; and in providing awards.

Awards are presented by organizations and government, the latter including the Army, Navy, Air Force, Coast Guard, Department of Homeland Security, etc. Each organization determines its own awards; in 2006, the Army presented 15 awards on the state level of three $1,000 U.S. Savings Bonds, a certificate of achievement and a gold medallion, and regional awards of certificates, bronze medallion and T-shirt. Two students per region go to international level, receiving either:

Winners receive an all expense paid trip to Operation Cherry Blossom in Tokyo, Japan. Each trip winner will also receive three $1,000 U.S. Savings Bonds, $300 from the Association of the United States Army, a gold medallion and a certificate of achievement. In addition, One all expense paid trip to London International Youth Science Forum, three $1,000 U.S. Savings Bonds, $300 from the Association of the United States Army, a gold medallion and certificate of achievement.

❑ Program Goals and Objectives

The Intel ISEF provides an opportunity for the best young scientists from around the globe to share ideas, showcase cutting-edge science projects, and compete for over $3 million in awards and scholarships.

- **Program Promotion Methods and Responsibility:**

Volunteer judges are solicited by ARO program manager and/or from Army leadership of individual labs and installations.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None from Army

Current program metrics: None from Army

- **Strengths and Weaknesses of Program**

Comments from interviews with individuals who have served as judges for multiple years:

- Gives kids remarkable opportunity to see range here and also in other countries (UK, Japan).
- Provides good exposure to students of another side of Army (as opposed to "Army at war").
- It is not feasible or relevant to track ROI for the Army because the "payoff" comes far down the road; although one effect may be that students don't automatically eliminate Army as career.
- Number of judges is growing smaller b/c of funding limitations, while the number of students is increasing (i.e. last year there were 2 chemistry judges for 70 chemistry projects)

- **Program Recommendations:**

- Ensure that information on ISEF is included in general AEOP announcements about programs.

- **Recommended Metrics: N/A**

JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM (JSHS)

❑ Program Overview

Date established: 1968 by ARO; 1996 joined by Navy and Air Force

Lead Army Organization: ARO/Youth Science Programs

Management Structure: Program oversight by Army personnel; Academy of Applied Sciences provides management and promotion.

Participating Organizations/Locations: 47 colleges and universities

Participating Army Organizations in JSHS Regional program:
ARO
ARL
Armed Forces Communications-Electronics Association
Association of the United States Army
Society of American Military Engineers
Army Corps of Engineers,
Communications-Electronics Command
Military personnel stationed in Europe and the Pacific
US Army Tank-Automotive Research
Development and Engineering Center
ROTC Units at multiple campuses

Participating Army Organizations in National program:
ARO
ARL
Various host Army Organizations and staff

Annual Budget[12]:

Total Funding: FY04 - $1.0M; FY03 - $1.05M

- *Regional program:* Cost of symposia ($802,000); scholarships ($216,000); teacher awards ($24,000 awarded to teachers)
  [Some regions leverage funds and fund more, for example: Missouri had ~500; upstate NY ~ 600]
- *National program:* $296,500

Scholarships: $144,000 (18 students); support for London trip ($21,000); participant cost ($988)

Administrative cost is shared between services and universities; since universities receive no funding, viewed as "volunteers"

Target student population:
Grades 9-12; students who are U.S. citizens and permanent residents from all states and DOD schools; some outreach to schools with underrepresented populations capable of succeeding in the programs.

Student selection:

- Schools nominate candidates from program;

[12] All 3 services provide direct funding/student for food and lodging (used to do travel but not much anymore b/c too expensive); doesn't cover cost of teachers

- Universities administer regional symposia and invite participation of high school students who have completed a research investigation in science, engineering or math. These students vie for awards and the opportunity to advance to the National Symposium.
- Students submit a written report (e.g. abstract and/or paper) of the original research investigation for review by a regional panel of judges
- Students deliver a concise oral presentation to the symposium

Number of Students Served:

Regional program: approximately 9800

National program (FY05): 240 student delegates; 48 students competing for military-sponsored scholarships.

Number of Teachers Involved (2005 National program): 96

Number of Adult Leaders (2005 National Program): 160

Cost per student:

- *Regional program (annual average):* Cost per student per day ranges from $10 to $90 (includes military funding only)
- *Regional program:* Regionals + scholarships + teacher awards divided by number of students and teachers participating = $106 per head
-

Growth Trajectory: Increases in costs of travel, lodging and other expenses have increased necessary cost per student and cut into ability to expand numbers of participants.

❑ **Brief Program Description:**

The Junior Science and Humanities Symposia (JSHS) Program promotes original research and experimentation in the sciences, engineering, and mathematics at the high school level, and publicly recognizes students for outstanding achievement.
The annual competition is designed to encourage and develop oral presentation skills and the ethical conduct of original research.

JSHS regional symposia, hosted and overseen by designated universities, invite high school students who have completed an original research investigation in the sciences, engineering, or mathematics to apply to the regional symposium and vie for awards, including the opportunity to advance to the National symposium.

The Regional Symposium winner and four additional students in each region are provided an all expense paid trip to attend the National Symposium. Awards at the National include: eight $16,000 undergraduate tuition scholarships (each 1st place finalists); eight $6,000 undergraduate, tuition scholarships (each 2nd place runner-up finalist); eight $2,000 undergraduate tuition scholarships to each 3rd place runner-up finalists. In addition, each first place finalist is awarded an expense-paid trip to the London International Youth Science Forum.

❑ **Program Goals and Objectives**

- Widen the pool of trained talent prepared to conduct research and development vital to our nation, by connecting talented students, their teachers, and research professionals at affiliated symposia and by rewarding research excellence.
- Support and encourage the success of high school teachers in addressing the attainment and mastery of state and national performance and process skills standards in the sciences, mathematics, and languages arts by their students.
- Promote research and experimentation in the sciences, engineering and mathematics at the high school level
- Recognize the significance of research in human affairs and the importance of humane and ethical principles
- Expand the horizons of research-oriented students by exposing them to opportunities in government, academia, and industry

❑ **Program Promotion Methods and Responsibility:**

The contractor, Academy of Applied Sciences (AAS), has responsibility for:

- Identifying the host institutions, communicating with interested institutions about JSHS and the work requirements, and maintaining a list of institutions capable of conducting the regional symposia;
- Publishing materials, such as the RFP, brochures, website information, news releases;
- Traveling to regional symposia to monitor and evaluate their success;
- Overseeing the advisory committees at the regional and national symposia level.

The universities that serve as hosts for the regional program are responsible for local/regional promotion, which varies according to the university and other organizations.

The Army's external promotion is primarily via the AEOP and JSHS program website, and individual Army personnel and/or locations who are involved with the program.

❑ **Data/Outcomes/Other Metrics:**

Formal or information evaluation:

Attitude survey of scholarship student delegates and adult leaders (2005: 30% of 240 students responded), that focuses on satisfaction/dissatisfaction with competition, and interest in STEM and plans for college study. The 90% positive response rate in each category suggests that participants in JSHS are already candidates for study/career in STEM fields, and that 89% had participated in other science competitions.

Current program metric:

- Number of undergraduate scholarships awarded:

1996-2003: Army has awarded 311 undergraduate scholarships

- Number of winners who subsequently enrolled in graduate school (via survey)

56 out of 311 scholarship winners were enrolled in graduate school. 3 of the 56 reported plans to pursue a Ph.D. (and one was for MD). Not a good ratio for getting a researcher.

- Number of scholarship recipients who remained connected to government:

50% of the recipients who responded to survey and participated in research beyond high school did so on the government or military dollar; although significantly more students used funding from NSF and NIH.

Each symposium lasts 2-3 days and therefore too limited a timeframe for useful measurement. There currently is no pre-testing/assessment, but this could be established on the regional level.

❑ **Strengths and Challenges**

The Army's participation is primarily at the competition level (regional and national) which provides opportunities for visibility and information for students, but little mentoring. According to the contractor and respondents to 4 surveys sent randomly to a sample of university program managers, the Army local leadership offers little support to JSHS in identifying military personnel for participation in the regional symposia. There is frequently a lack of communication between the military (the 3 services take turns hosting the national competition) and the regional university. This may result in part because attachment to JSHS is occurs at the individual level (judges), rather than to an Army lab.

The armed services added scholarship funding some years ago. From the contractor's perspective, this led to JSHS becoming more competitive, with the characteristics of a contest rather than an opportunity to develop and present research. The four survey respondents noted efforts and success in reaching all ofo the schools in their area; each also described an increase in requests for participation and an increase in recommended students.

The static level of military funding inhibits expansion in numbers of students that can be involved via military dollars. At one point, there was some discussion about putting the symposia on the Internet, in order to reach more students and reduce costs. The regions argued in opposition that face to face interaction and presentations with peers and professionals was too important for students to eliminate. In addition, there is a lot of exposure during the national symposium to military R&D as a career option, so the military remains a strong proponent of maintaining the face to face interaction.

There has been a decline in the number of high schools that participate, apparently because the No Child Left Behind Act has had an effect on student participation in independent research projects. Further, the requirements for NCLB testing has prompted high schools with large socio-economically disadvantaged populations to increase focus on teaching for the test, reducing available teacher and student time for this type of program.

There is some concern about habitual funding of the same universities; although there has been no suggestion that some universities are not fulfilling their responsibilities. There appears to be little across the board assessment of this, however. There also appears to have been no examination of whether there are universities that have become better positioned to host the regional symposium than the one initially chose some decades ago.

❑ Program Recommendations

- Expand outreach to Army labs and contractors that are located in the university regions, in order to establish awareness of JSHS and to encourage opportunities for Army personnel to participate on local JSHS review panels and boards.
- Consider involving the Army Centers of Excellence as participating universities.
- Offer more professional development for teachers during the regional and national symposia.
- Extend REAP's student eligibility to include 9th grade, and promote REAP as opportunity for "next steps" for JSHS participants.
- Explore possibilities for expansion of number of universities in order to provide more or new locations, such as pairing universities for alternate year hosting.

❑ Recommended Goals

Expanded Army awareness of JSHS and potential value of identifying these students for potential internships and career development.

❑ Recommended Metrics

- Standardize the regional assessment instruments, which vary from minimal attitudinal surveys among students and teachers to detailed requests of the university managers about students, success in recruitment, fundraising to support additional students, etc.
- Do longitudinal study of the winners and participants as they progress from undergraduate to graduate school and into STEM careers.

THE INTERNATIONAL MATHEMATICS OLYMPIAD (IMO)

❑ Program Overview

Date established: The IMO began in 1959; the USA has participated since 1974.
US Program under the auspices of the Mathematical Association of America.

Lead Army Organization: ARO/Youth Science Programs

Management Contractor (for entire program): University of Nebraska

Participating Organizations/Locations: SMDC, AMRDEC, ERDC (Vicksburg)

Annual Budget:
The Army provides the necessary funding for the travel of the team to represent the United States at the International Mathematical Olympiad.
IMO held in different country each year.

Target student population:
Open to students 20 years of age and under with no post-secondary school education, who are U. S. citizens and students legally residing in the United States and Canada.

Student selection:
Approximately 250 of the top scoring American Mathematics Competition participants are invited to take the US American Math Olympiad. The twelve top scoring USAMO students are invited to a two day Olympiad Awards Ceremony in Washington, DC sponsored by the MAA, the Akamai Foundation, the Microsoft Corporation and the Matilda Wilson Foundation. Six of these twelve students will comprise the United States team that competes in the "International Mathematical Olympiad (IMO).

Number of Students Served: U.S. team comprised of six students, with two adults.

Cost Per Student: Not Available

❑ Brief Program Description:

The USAMO is part of a worldwide system of national mathematics competitions, a movement in which both educators and research mathematicians are engaged in recognizing and celebrating the imagination and resourcefulness of our youth. The USAMO is a six question, two day, 9 hour essay/proof examination. All problems can be solved with pre-calculus methods.

❑ Program Goals and Objectives

- The USAMO (United States of America Mathematics Olympiad) provides a means of identifying and encouraging the most creative secondary mathematics students in the country. It serves to indicate the talent of those who may become leaders in the mathematical sciences of the next generation.
- The members of the Committee on the American Mathematics Competitions (CAMC) are dedicated to the goal of strengthening the mathematical capabilities of our nation's youth. The CAMC believes that one way to meet this goal is to identify, recognize and reward excellence in mathematics through a series of national contests called the American Mathematics Competitions.

❑ Program Promotion Methods and Responsibility:

There appear to be none that are generated by the Army. The ARO home page includes the choice of "outreach programs" in its lengthy menu; the outreach programs page includes IMO but no reference to Army sponsorship or what it's for. The AEOP website refers visitor to IMO home website, which is hosted by Canada. Clicking on USA

sends the visitor to the Mathematical Association of America competitions home page, which includes 10+ menu tabs. The tab labeled "who's who" lists "Sponsors", which are the Math Association, University of Nebraska, ONR and ARO. There is no other information provided.

- **Data/Outcomes/Other Metrics:**

The US team consistently ranks in top 3 countries of more than 80 represented

Formal or informal evaluation: Success in competition.

Current program metrics: Success in competition and US rank among all nations that participate.

- **Strengths and Challenges**

The IMO is not an Army program but a program that receives some funding from the Army. The strengths and challenges of the IMO system itself are beyond the scope of this analysis.

- **Program Recommendations**

If the Army continues to provide funding, the primary challenge is how to increase Army branding both within the national and international mathematics competition community and also within the Army S&T community.

MATERIALS WORLD MODULES (MWM)

❑ Program Overview

Date established: 1994: Developed by Northwestern University under an NSF grant
2003: Adopted by DOD/Army (championed by former Deputy Under Secretary John Hopps)

Lead Army Organization: Armament Research Development & Engineering Center (ARDEC), Picatinny, New Jersey; DOD Ordnance Technology Consortium

Management Structure: MWM is managed internally by a dedicated half-time contract employee, and supported by another half-time contract employee, both of whom are retired military officers.

Participating Organizations/Locations: 4

RDECOM—ARL, Aberdeen Proving Ground, MD
County College of Morris, Randolph, NJ
Naval Surface Warfare Center—Indianhead, MD and New York—Benet

Annual Budget:

- $200,000 in FY06 from the Army.
- DOD is investing $500,000 in FY2006 to support the Summer Institute at Garrett College, and $2 million to begin scale-up in Maryland in FY06.
- $5 million has been requested in the Administration's FY07 DOD budget to support MWM roll-out in Maryland, and begin a national scale-up.

Target student population:

- Middle and high school students.
- During the pilot phase, geographic locations have been limited to a few school districts proximate to Army laboratories.
- MWM's goal is to launch state-wide in Maryland starting in the fall of 2006, and then expand nationally.

Student selection:

- Teachers elect to use MWM content in their regular classes.
- School districts must sign an Educational Partnership Agreement.

Number of Students Served (2005): 6,600

Number of Participating Teachers: 55-65

Estimated Cost Per Student: $10 per student (each $750 kit contains materials for 75 students). Does not include professional development for teachers, administrative or overhead costs.

Growth Trajectory: DOD plans to roll MWM out statewide in Maryland over a three year period. MWM plans to work through the Maryland Community Colleges, and the resources anticipated from DOD appear adequate to accomplish this plan.

❑ **Brief Program Description:**

The Materials World Modules (MWM) Program has produced a series of interdisciplinary content modules based on topics in materials science, including Composites, Ceramics, Concrete, Biosensors, Biodegradable Materials, Smart Sensors, Polymers, Food Packaging, and Sports Materials. The modules are designed for use in middle and high school science, technology, and math classes. MWM is based on principles of inquiry and design, and emphasizes active, hands-on learning. MWM provides middle and high school students of all ability levels with opportunities to apply what they learn in the classroom to real-world problems, while helping teachers to meet National Science Education Standards.

Developed at Northwestern University in 1994, the MWM Program was established to develop and disseminate supplemental materials education curricula for high school students. Given the pervasiveness of materials in everyday life, the developers of MWM felt that the study of materials would facilitate students' discovery of the interconnections between science, technology, and society.

Each MWM module focuses on a specific type of material. Nine modules have been created thus far, and each module was field tested by high school teachers in a wide array of courses, including chemistry, physics, biology, earth science, physical science, technology and engineering, and mathematics. Teachers in all subject areas reported that the use of the modules enabled students to make connections between concepts from the traditional curriculum and the world around them more frequently than ever before. Teachers also reported gains in content knowledge and design capabilities based on pre and post-tests.

❑ **Program Goals and Objectives**

- Strengthen U.S. talent pool for science, math and engineering.
- Increase the number of U.S. students pursuing careers in science, math and engineering.
- Provide content to enrich school curriculum and spark students' interest in science, math and engineering.
- Maximize resources and value by using leading edge techniques like distance learning.
- Measure and evaluate program performance for improvement opportunities for justification.

❑ **Program Promotion Methods and Responsibility:**

The program is promoted by the Army, DOD and Northwestern University through training teachers, distribution of MWM kits, and participation of volunteers in schools located near DOD research facilities. MWM kits also have been distributed to the science teachers who advised the national winners of the eCYBERMISSION competition. Promotional activities, targeted at pilot sites in New Jersey and Maryland, include participating and exhibiting at national and regional events, maintaining a web site, distributing program brochures, and through word of mouth. MWM also currently uses an informal "ambassadors" program through which Army scientists are recruited to reach out to their local schools and share information about MWM. These ambassadors are encountering resistance from some schools, while other schools are accepting the MWM kits, but not necessarily using them in their classrooms.

Another element in MWM's current dissemination efforts is to provide teacher training on both inquiry-based learning, as well as introduction of the MWM modules. A few teacher training sessions already have been held, most recently, in early July for a group of approximately 20 teachers.

MWM has now adopted an aggressive dissemination strategy to "saturate" the State of Maryland over the next three years, in partnership with Garrett Community College. The first step in the Maryland roll-out will be conducting a formal evaluation of MWM, as described in the evaluation section below. Once that evaluation is complete, and assuming successful results, MWM is poised to work with Garrett to disseminate MWM throughout the State of Maryland by the end of 2008. Maryland was selected because of the significant DOD laboratory and contractor presence, and the resulting availability of volunteers.

Garrett will house a statewide resource Center to help schools and teachers adopt the content. MWM will also work through state accrediting processes to have MWM adopted as supplementary curriculum for middle and high school students. Using DOD funds, Garrett will provide small grants to educational partnerships led by local community colleges to help the community colleges work hands-on with their local schools to train teachers, and provide services needed to introduce MWM curriculum in as many middle and high schools as possible throughout Maryland.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: Because MWM will be delivered in science classrooms in Maryland, MWM has aligned its content with Maryland science standards, and will conduct an evaluation during the summer of 2006 using rigorous evaluation protocols consistent with Department of Education guidelines. 96 students from throughout the State of Maryland will participate in a full-day educational program for four weeks. Half of the students will be taught using MWM, and the other half of the students (the control group) will be taught the same principles of math and science that are embedded in the MWM modules using more traditional methods of direct instruction. Students will be tested weekly to determine their level of achievement, as well as attitudes toward the study of science and interest in science careers.

This study will provide the DOD and the Army with evidence regarding whether or not MWM is effective in improving the achievement of participating students, as well as generating an interest in pursing additional math and science courses.

Current program metrics:

- A log is kept recording kit distribution at pilot sites.
- Pilot sites report informally on the number of teachers who use the MWM modules, and how many students are reached.
- DOD volunteers solicit feedback from teachers at pilot sites.
- Reporting metrics for MWM will be assumed by Garrett College.

- **Strengths and Challenges**

MWM's greatest strength is the development and testing of engaging content. The MWM content was developed under an NSF grant, with both science and engineering faculty and high school teachers participating in development. MWM content is inquiry-based, and inquiry-based approaches have consistently been found more effective than traditional science curricula, as measured by student achievement.[13] Content was tested and refined based on testing with more than 5,000 students and extensive teacher feedback. The MWM content is being evaluated to determine effectiveness in impacting student achievement and attitudes. In addition, the content was developed to meet National Science Education Standards. As a first step to widespread dissemination in Maryland, the MWM content also is being aligned with Maryland standards.

The MWM program faces a number of significant challenges, however. First, because MWM will be delivered in the classroom, it will be subject to all the same pressures as other parts of K-12 education, and the DOD/Army will be working in an area where it has very limited experience. Ultimate success of MWM will depend heavily on the willingness of schools and school districts to sign educational partnership agreements, and the quality and commitment of the teachers who agree to use MWM in their classrooms.

For example, during its pilot phase, MWM modules have been disseminated through an informal ambassador program through which participating Army volunteers work directly with local schools to encourage teachers to adopt MWM content in their classrooms. A number of the volunteers involved in the dissemination reported that many of the teachers who received the kits never used them, or waited until the end of the school year to do so.

[13] What Do We Know?: Seeking Effective Math and Science Instruction, Beatriz Chu Clewell and Patricia B. Campbell, Urban Institute, p. 3.

To address these challenges, MWM is working on a statewide dissemination strategy by gaining the support of the Maryland State Superintendent, as well as the state's 24 science coordinators. DOD is also contracting with Garrett County Community College to establish a statewide resource Center to help schools and teachers adopt MWM, and Garrett will also engage community colleges across the state (which already have hands-on working relationships with the school districts and individual schools).

This effort should move somewhat beyond the Army's traditional reliance on volunteers working school-by-school to promote AEOP programs. However, the three-year time horizon and multi-million dollar investment planned for the Maryland roll-out would indicate that sufficient resources will not be available to DOD to scale MWM to national impact on a state-by-state basis unless MWM succeeds in gaining broad sponsorship and substantial financial support from other STEM-based Federal agencies and science and technology-based companies. In addition to the high cost of the MWM expansion strategy, the time horizon for national impact would be many years.

Even as MWM overcomes the challenge of disseminating MWM effectively in one or more states, several elements of program success will remain in control of the teachers and schools adopting MWM, including the dosage/duration of the intervention. The MWM modules are estimated to take about 100 hours of total class time, and since they are most frequently used as a supplement to regular curriculum, even the most engaged teachers will use just a few modules per year. Other than providing MWM teachers with the best possible training, which MWM seeks to do, MWM has no control of whether and how teachers actually use MWM, and little impact on the level of adult engagement and personalization of the program. Some schools may include individualized mentoring and tutoring as part of their program, while others may not. In addition, to the extent that the students exposed to MWM improve their math and science achievement, it is going to be difficult to demonstrate that MWM caused the improvement.

A final possible challenge for MWM is that participating students do not necessarily see the connection between MWM and DOD science and engineering careers. In fact, many students may not be aware that DOD is funding the program. (Teachers and administrators will be aware that DOD is funding the MWM program, because they will have some degree of interaction with DOD volunteers). A key factor in overcoming this challenge will be whether MWM can develop a significant and meaningful role for its volunteers in the classroom. MWM anticipates calling on DOD volunteers to work with students in the classroom during the design phase of each MWM module, when students will, for example, create their own composites or sports materials, etc. MWM hopes this will be an opportunity for DOD volunteers to advise students on military science careers, and what it is like to work in a laboratory setting.

❑ Program Recommendations

Clarify Program Goals. Based on the MWM evaluation plan and dissemination strategy, it appears that MWM seeks to improve student achievement in math and science, as well as impact student attitudes toward science. The current stated goals are "strengthening the U.S. talent pool", and "increasing the numbers of domestic students pursuing math and science careers." The first of these is vague. It is unclear whether the second goal can be achieved by offering MWM through school-based experiences; special testing may be needed to determine whether MWM impacts the decisions and achievements of economically disadvantaged students and groups traditionally under-represented in science, engineering and technology.

Strengthen the Partnerships Among DOD Volunteers and Participating Schools. Maryland was chosen for a statewide roll out of MWM because of the significant presence of military laboratories and private military contractors in the state. Rather than utilizing this pool of prospective volunteers to introduce MWM to individual schools and teachers (as was done during the pilot phase, but which will be unnecessary, given the statewide dissemination strategy), MWM volunteers should be trained and used to visit schools to perform experiments with students.

Partner with Large States With a Significant Military Presence. If the launch in Maryland is successful, MWM should consider partnering with additional large school systems in states with a large military laboratory presence in the state. This will enable DOD to use the Maryland experience as a model for expansion in these states. Moreover, large school systems—such as California, New York, Texas and Florida—dominate K-12 education, and influence

curriculum adoption throughout the country, so partnerships with those states could serve as catalysts to adoption elsewhere.

Consider Partnering With a Commercial Publisher. In MWM, DOD has a high-quality product, aligned with education standards, with increasingly proven efficacy. However, DOD lacks the resources and marketing channels to disseminate this product nationwide in a timely and cost-effective fashion. DOD may want to consider engaging in discussions with commercial education publishers to explore how they might collaborate with DOD to disseminate MWM more broadly and faster.

❑ Recommended Goals

- Increase interest in science, math and technology among middle and high school students.
- Raise awareness and interest in science and engineering careers.
- Provide a strong link to DOD/Army scientists and engineers and the wide variety of interesting careers in military science.
- Encourage students to take advanced math and science courses in high school.
- Encourage students to attend college, and pursue majors in science, engineering or mathematics fields.

❑ Recommended Metrics

- Increased knowledge of the role of materials in every day life, based on pre and post-tests.
- Impact on student achievement based on pre and post-tests.
- Student attitudes toward the MWM experience, based on pre and post-tests.
- Student attitudes toward science based on pre and post-tests.
- Student self-confidence relating to scientific tasks, based on pre and post-tests.
- Level of interest in science and engineering careers, including military science careers, based on pre and post-tests.

GAINS IN THE EDUCATION OF MATHEMATICS AND SCIENCE (GEMS)

❑ Program Overview

Date established: 1992

Lead Army Organization: WRAIR

Management Structure: GEMS is overseen by volunteer researchers who are full-time scientists, and previously had one dedicated manager working under their direction.

Participating Organizations/Locations: 5

Walter Reed Army Institute of Research, Silver Spring, MD
Army Research Lab (ARL), Adelphi, MD
Army Research Lab, Aberdeen Proving Ground, MD
Aviation and Missile Research and Engineering Center (AMRDEC), Huntsville, AL
George Washington University, Washington, DC

Annual Budget: $500,000

- The $250,000 budget for WRAIR is currently supported by a grant from NIH's Science Education Partnership Award Program (SEPA) through August 2006.
- $250,000 is provided by ASAALT for expansion of GEMS to additional locations.

Target student population:

- GEMS 1: 8th through 12th grades
- GEMS 2: 10th through 12th grades
- GEMS 3: 11th through 12th grades
- "Disadvantaged" school districts, defined as lacking quality science-based activities and opportunities.
- Groups under-represented in science and engineering careers; however, other student groups are not excluded, and the GEMS program reflects local area demographics.
- Students must be located within commuting distance of a participating Army or university location.

Student selection:

- Candidates for the program are identified through their participation in the Washington, DC city-wide science fair.
- Students complete applications, and are encouraged to write essays.
- Students are selected based on enthusiasm, willingness to learn science, quality of written essays and teacher recommendations. Selection is not based on prior achievement.

Number of Students Served (2005): 218

Cost Per Student: $450 to $750, including payment of student stipends.

Growth Trajectory: GEMS is growing rapidly, as additional Army laboratories adopt the program.

- **Brief Program Description:**

One to four week programs are established for each summer in which younger junior/senior high school students perform short experiments illustrating basic scientific principles, while being guided by senior high school and college students, with the help of a full-time program administrator and a resident teacher for the summer.
The programs are designed such that successful students return in future summers to do even more sophisticated studies so that they may eventually become part of the 8-week Science and Engineering Apprenticeship and other advanced science activities. Research scientists, in conjunction with their college assistants, design age-appropriate protocols relating to current research.
Program directors and GEMS leaders also offer help to students with respect to guiding/working with parents, raising teacher expectations, aiding in SAT preparation, providing information for financial aid resources for a variety of educational services and tips for the college application process.
Students receive a stipend of $100 for each week of GEMS participation.

- **Program Goals and Objectives**

  - Identify science-enthusiastic youth from school districts lacking quality science-based activities and opportunities. Mentoring each student over an extended period of time and in various ways to nurture his or her interest in science.

  - Expose participating students to progressively more challenging lab experiences over multiple years to build each student's self-confidence in his ability to succeed in science and technology.

  - Demonstrate that learning is life-long, worthwhile, cool and fun.

  - Encourage students to attend college, and to continue their science education.

- **Program Promotion Methods and Responsibility:**

To date, most GEMS students have been recruited from the National Capitol Area. All students submitting projects to the DC city-wide science fair are invited to participate in GEMS. In addition, all National Capital Area middle schools are provided with program brochures, application materials, and instructions. GEM points of contact also reach out to teachers throughout the year, and connect to classroom activities.

GEMS brochures are disseminated at national scientific, Army and science outreach meetings.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: An annual evaluation is performed by an independent evaluator, as required by the terms of WRAIR's NIH grant.

Current program metrics:

- Growth in number of students participating
- Number of students who return to GEMS each year
- Number of students who transition from GEMS to SEAP (and become near peers)
- Expansion of program to additional laboratories and locations
- Student attitudes toward the GEMS experience, based on pre and post-tests
- Student attitudes toward science based on pre and post-tests
- Student self-confidence relating to scientific tasks, based on pre and post-tests

- Level of interest in military science careers, based on pre and post-tests

❑ Strengths and Challenges

GEMS is an informal science education program seeking primarily to excite and interest students from disadvantaged middle and high schools in science, and encourage these students to attend college, and select science and engineering majors. The GEMS model has several features that are aligned with best practice principles for informal science education:

Content: A variety of age-appropriate experiments have been developed to engage the students in fun hands-on activities. In addition, students are offered progressively more challenging and independent work as they move through the GEMS program each year, which serves to build their self-confidence, and help nurture an interest in studying more demanding science in school.

The pre and post-tests administered in connection with the most recent GEMS evaluation show that the GEMS participants overwhelmingly enjoyed performing experiments and working with other students in the laboratories. Therefore, the GEMS content would appear to enable the program to meet the goal of building students' interest in science. However, as other laboratories increase their participation in GEMS, it will be important for each laboratory to develop its own curriculum and experiments that best fit each laboratory's resources and culture.

Dosage/Duration: In addition, GEMS expressly seeks to engage and mentor students over a long period of time. Although it is possible for students merely to participate in a GEMS 1 program for a week and never to return, emphasis is placed on encouraging the same students to return year after year. In addition, highly-qualified GEMS students can advance to the Science and Engineering Apprenticeship (SEAP).

Among volunteers supporting the GEMS and SEAP programs, there was a strong consensus that it is far more valuable to give priority to returning students each year, rather than to serve more students for relationships of shorter duration. GEMS offers anecdotal evidence that a number of students who participate in GEMS for a few years are making choices to continue to engage in science education.

Engaged Adults: GEMS provides a good deal of adult support and encouragement for each GEMS participant, including scientist mentors, a resident teacher at each laboratory, and near peer mentors, who not only supervise the students' work, but serve as positive role models for the students.

Personalization: GEMS mentors appear to offer a good deal of support to GEMS students to encourage them to take challenging math and science courses in high school. This appears to happen on an informal basis, as the mentor/protégé' relationships develop. In addition, the near-mentors are an outstanding group, and their contributions to the students' experiences are significant. Moreover, the work of the near-peers takes some of the pressure of mentoring off of participating scientists.

Program challenges include the limitation on growth posed by the lack of adequate facilities to accommodate all interested students, and the high level of volunteer resources required to host young students in the laboratories. Unlike the SEAP program, in which students are integrated into the ongoing work of the laboratory, GEMS students are offered a somewhat artificial or contrived lab experience. This both adds to the work necessary to host a GEMS student, and may serve to discourage laboratory adoption and expansion of GEMS.

❑ Program Recommendations

Clarify Definition of Target Student Population. The stated goal of targeting students from "disadvantaged" school districts (those without quality science opportunities) is too vague. WRAIR has always applied that definition to justify selection of students from the District of Columbia. Instead, the Army may want to consider focusing on an objective definition of "economic disadvantage"—for example, the number of students in a school or district qualifying for free or reduced-cost school lunches—and open GEMS to all schools and school districts in the vicinity of participating Army labs that meet this objective definition.

Make Model Flexible for Transfer to Other Army Locations. The experience with expanding the GEMS model to other Army locations has demonstrated a need for greater flexibility in application of the GEMS program model to other locations. The efforts last summer demonstrate the difficulty in taking a cookie cutter approach to sharing *any* program across the laboratories. Some of the content developed at WRAIR was not easily transferable, and the security and facilities issues, as well as skills of the volunteer scientists, frequently dictated a different approach.

Rather than applying a "one-size fits all" approach to GEMS, the Army would benefit from preparing a set of "turnkey" guides (such as those used in eCYBERMISSION) to explain the overall program, and each volunteer's role in it. Then, each Army site should work to develop its own variation on the program, based on these standardized information pieces.

❑ Recommended Goals

- Identify science-oriented students from disadvantaged school districts.
- Offer students a progressive series of meaningful work experiences in Army laboratories over multiple years.
- Encourage students to take advanced math and science courses in high school.
- Encourage students to attend college, and pursue majors in science, engineering or mathematics fields.

❑ Recommended Metrics

- Number of GEMS pursuing advanced math and science studies in high school.
- Number of GEMS who transition from GEMS to SEAP (and/or become near peers).
- Number of GEMS who enter college.
- Student attitudes toward science based on pre and post-tests.
- Level of interest in military science careers, based on pre and post-tests.
- Number of GEMS who select science and engineering majors in college.

SCIENCE AND ENGINEERING APPRENTICE PROGRAM (SEAP)
COLLEGE QUALIFIED LEADERS (CQL)

❑ Program Overview

Date established: 1981

Lead Army Organization: Medical Research and Materiel Command (MRMC)

Management Structure: Overall program oversight for SEAP and CQL is provided on a volunteer basis by a full-time Army employee who is primarily assigned to other duties. Administrative support is provided by The George Washington University under contract.

Participating Organizations/Locations: 16

Army Research Lab (ARL), Adelphi, MD
Army Research Lab, Aberdeen Proving Ground (APG), MD
Army Research Lab, Sensors and Electronic Devices Directorate
Army Research Lab, Survivability and Lethality Analysis Directorate
Army Research Lab, Weapons and Materials Research Directorate
Communications-Electronics Research Development and Engineering Center
Edgewood Area, APG
Natick Soldier Center (NSC)
Research, Development and Engineering Command, Rock Island, Illinois
Redstone Arsenal, Alabama
Engineer Research and Development Center—Topographic Engineering Center (ERDC-TEC)
Army Medical Research Institute of Chemical Defense
Walter Reed Army Institute of Research, Silver Spring, MD
Armed Forces Radiobiology Research Institute (AFFRI)
Defense Threat Reduction Agency (DTRA)
Naval Health Research Center (NHRC)

Annual Budget: $353,539, including $215,000 for administrative costs
$1,668,403 for stipends (paid primarily through the research budgets of participating mentors)

Target student population:

- SEAP: Open to high school students, 9th through 12th grades.
- CQL: Open to undergraduate and graduate students.
- Generally, students must be located within commuting distance of a participating Army location.

Student selection:

- Students complete applications, including writing a personal statement. Students also must provide teacher recommendations, school transcripts and standardized test scores, if possible.
- Selection for SEAP is highly competitive, with only about one-third of applicants accepted for placement in an Army laboratory. At WRAIR, only about 10% of applicants are accepted.
- Students are selected based on their GPA, standardized test scores, teacher recommendations, quality of their personal statements, and their areas of interest.

- Students are screened on the above criteria by George Washington University. Final placement is dependent upon finding a match with an appropriate mentor.

Number of Students Served (2005): SEAP: 153
CQL: 206

Number of Mentors (2005): 190

Administrative Cost Per Student(2005): $265

Growth Trajectory: Participation of mentors has eroded over a number of years. The availability of appropriate mentors, as well as funding for student stipends, are the major limiting factors on future growth.

❑ **Brief Program Description:**

The Science and Engineering Apprentice Program (SEAP) is an eight week summer internship program for high school students. SEAP is designed so that students can apprentice in fields of their choice with experienced scientists and engineers on mutually agreed projects.

The College Qualified Leaders (CQL) program offers eight week summer internship opportunities to undergraduate and graduate students.
The program seeks to offer work that is meaningful to both the apprentice and the sponsoring organization, tailored to the interests and capabilities of the student, and to provide a personally rewarding learning experience. A mentor is assigned to each apprentice to provide project supervision and on-the-job instruction, and to encourage learning and development. This "hands-on" experience gives students a broader view of their fields of interest and shows students what kind of work awaits them in their future career. At the end of the summer, the students prepare final reports and present their research at a final seminar, held at George Washington University.
First year participants are awarded an educational stipend of $1,545. CQL students receive a stipend of $6,951.

❑ **Program Goals and Objectives**

Science and Engineering Apprentice Program

- Encourage students to pursue science and engineering careers.
- Acquaint qualified high school students with the activities of Department of Defense laboratories through summer science and engineering research experiences.
- Provide students with opportunities in and exposure to scientific and engineering practice and personnel not available in their school environment.
- Prepare students to serve as positive role models for their peers by encouraging other high school students to take more science and math courses.
- Develop a student/citizen appreciation for the process and rigor of scientific research.

College Qualified Leaders

- Provide SEAP mentors with the opportunity to have fully-trained students return to their laboratory during their college years.
- Give mentors the opportunity to share their passion for science with talented undergraduates.
- Give SEAP students the opportunity to continue their research and training.

- Educate undergraduates and graduates about the research process by performing actual research.
- Provide a learning community for the developing professional.
- Prepare a new generation of scientists and mentors.

❑ **Program Promotion Methods and Responsibility:**

George Washington University has responsibility for program promotion. Program materials and application forms are sent annually to local high school principals, science and mathematics department chairpersons, and superintendents of schools. Public, private and parochial schools located in the vicinity of participating laboratories are included.

In the National Capital area, application forms go out to many of the most prestigious local high schools, including Thomas Jefferson, Montgomery Blair, Sidwell Friends, Madeira, Richard Montgomery and Bannaker. Outside the National Capital area, Army points of contact recommend the high schools in their communities that should be contacted.

SEAP is also promoted on several web sites, including AEOP, GWU, ARL and WRAIR.

CQL opportunities are not advertised; students involved in CQL learn about them through either their own prior participation in SEAP or GEMS, or through word of mouth. SEAP/CQL management have chosen not to advertise more broadly because the programs already are oversubscribed every summer. In 2006, more than 1,200 applications were received, and about 350 are expected to be placed this summer in Army laboratories.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics:

- Number of students participating.
- Number of students and mentors returning to the program each year.
- Of the approximately 135 students accepted for the summer of 2006, virtually all are returning students, and many are in their second or third year.

Qualitative metrics:

- SEAP/CQL contributes to the work in progress and to meeting laboratory metrics.
- SEAP/CQL is perceived to provide an advantage in recruiting extraordinary candidates.
- SEAP/CQL generates much interest and good will among talented young people that the Army would be unlikely be able to attract otherwise, and improves community relations.

❑ **Strengths and Challenges**

SEAP is a mature, efficiently run, and apparently effective internship program. With the exception of SEAP students who become near peer mentors (and therefore, have a more standardized set of activities), the overall quality of the learning experience is highly dependent on the efforts of the mentors. However, the fact that many students return year after year, and build long term relationships with their mentors, would indicate that these relationships are functioning reasonably well.

Content: For the most part, the mentors we interviewed appeared to be providing meaningful, real-world research experiences to their apprentices. Most engaged the apprentices in their ongoing research to the extent possible, so there is a very good exposure to both military science as well possible career opportunities. However, finding projects appropriate for high school students was a challenge for some mentors, and many mentors indicate reluctance to work with high school students.

Dosage/Duration: A number of mentors suggested that an eight week program is too brief to provide the best possible research experiences to students, and that the short duration of the internship places an additional burden on mentors. Consideration should be given to extending the program to ten or twelve weeks for interested mentors and students, which appears permissible under DOD guidelines, which permit apprentices to work up to 1,040 hours per year throughout their high school and college years, so long as the work assignment is related to their studies.

Engagement, Personalization and Commitment: Perhaps the greatest strength of the SEAP/CQL program is the high level of adult engagement and personalization of the program, together with the passion and commitment of the SEAP mentors. Of the many mentors we interviewed, all believe passionately in nurturing the next generation of scientists and engineers, and most find a great deal of value in the work done by the apprentices. Each year, mentors give top priority to returning students because they see the importance of developing a continuing relationship with these students.

❑ Program Recommendations

Clarify Program Goals. The stated goals for SEAP vary depending upon laboratory location, and goals are stated differently on the AEOP web site than in SEAP/CQL presentations. In addition, some goals, such as "preparing students to serve as positive role models for their peers by encouraging other high school students to take more science and math courses," are probably overly ambitious, and cannot be measured. The program would benefit from having a few, very clear goals, all of which are tied to specific metrics.

Expand Program Within Existing Locations and To New Locations. This year, the SEAP program attracted 1,200 applicants with only minimal efforts at advertising, demonstrating that there is a clear student demand for hands-on research experiences in Army laboratories. Even at laboratories—such as WRAIR—that already accept a large number of students, there appears to be additional capacity to accept students.

One of the greatest deterrents to expansion at this point appears to be the requirement that each mentor fund the apprentice through his or her own research budget. In a time of declining research budgets, this has placed a great strain on individual investigators. Thus, over time, the number of participating mentors has declined, until what remains now is the core of the most dedicated SEAP mentors.

At low cost to the Army, this incentive structure could be changed. The total cost for each SEAP student averages $1,810, while the cost for a CQL student averages $7,216. The Army should consider partially subsidizing the cost of new SEAP/CQL apprentices during the first couple of years with a mentor. According to the current mentors, these students do such great work, that after an initial experience, mentors begin to find their apprentices indispensable, and choose to pay their stipends themselves. In addition, ASAALT should consider establishing overall expectations or guidelines for laboratories emphasizing the importance of creating student internship opportunities and mentoring within each laboratory.

Disseminate Information About SEAP/CQL Authorities Throughout Army S&T Community. SEAP/CQL provides a very flexible and inexpensive authority and set of rules that could support a wide variety of Army laboratory-based research experiences for high potential high school, undergraduate and graduate level students. However, the lack of awareness of this program could be limiting its potential reach, particularly in parts of the Army S&T community not currently fully engaged in AEOP programs, such as, for example the University Affiliated Research Centers. At least one of the UARCs has recently begun a project to foster opportunities for graduate and undergraduate students performing research at the Center to participate in summer internships at Army laboratories. Lack of knowledge of existing Army programs supporting summer internships—both within the UARC, and among Army points of contact working with the UARCs—was a significant barrier to creating an appropriate program in a timely manner.

Anyone in the extended Army S&T community should have prompt and easy access to the entire Army toolkit to create opportunities for the Army to access quality talent being trained at the UARCs. Since this knowledge was not available, the opportunity to benefit from high potential students referred by one of the UARCs was not available to the Army.

For CQL Students, Consider Eliminating Geographic Limitations to Opportunities.
Undergraduate and graduate students have much more ability to work at numerous geographic locations. Rather than limiting their opportunities to laboratories within commuting distance of their homes, CQL students should have the opportunity to work at a variety of locations across the Army S&T community, so long as they can make appropriate living arrangements during the term of their summer experience.

Consider Closer Linkage to Army Science and Engineering Workforce Needs. SEAP and CQL attract students who have high achievement levels in science, engineering and math studies. They are therefore a potentially fertile source of future Army scientists and engineers. Explicit attention should be paid to matching these students with appropriate mentoring and research opportunities throughout their college and graduate programs. In addition, the Army should consider advertising appropriate vacancies to this group, or make Army career opportunities known to the CQL students through web sites and other methods of communication.

❑ Recommended Goals

Science and Engineering Apprentice Program

- Identify high potential students.
- Offer students a progressive series of meaningful work experiences in Army laboratories over multiple years.
- Encourage high-potential students to take advanced math and science courses in high school.
- Encourage high-potential students to pursue majors in science, engineering or mathematics fields.

College Qualified Leaders

- Encourage high potential students to persist in STEM studies.
- Encourage high potential students to pursue STEM degree completion.
- Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
- Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

❑ Recommended Metrics

- Number of SEAP students pursuing advanced high school science and math courses.
- Number of SEAP students who return to the program each summer, or move from SEAP to CQL or other Army lab experiences (summer or school year).
- Pre and post-testing for attitude toward S&E careers.
- Number of SEAP students who enter college.
- Number of SEAP/CQL students who select science and engineering majors in college.
- Number of SEAP/CQL students graduating with a science or engineering degree.
- Number of SEAP/CQL students who become Army employees or military scientists or engineers.

UNINITIATES' INTRODUCTION TO ENGINEERING (UNITE)

❑ Program Overview

Date established: 1980

Lead Army Organization: ARO

Management Structure: Army personnel oversight; with Junior Engineering Technical Society (JETS) managing and coordinating program through program officers at individual college/university sites.

Participating Organizations/Locations: The program takes place on campuses of HBCU/MIs, the number of which vary. Currently there are 7 sites, including - University of New Orleans; Colorado State University; Florida International University; NJ Institute of Technology Women's Center; New Mexico University - MESA; University of Delaware; University of Detroit – Mercy

Annual Budget:
FY05: Total - $290,000; 7 sites ($30K/site) - $210,000; Administration - $80,000
FY04: Total - $200,000; 5 sites - $150,000; Administration - $50,000
FY03: Total - $170,000; 4 sites - $120,000; Administration - $50,000

Target student population:
Historically under-represented, and socially/economically disadvantaged high school students.

Student selection:
Application through the schools and university websites, determined by the university and its program coordinators. They may use wide latitude in selecting students

Number of Students Served:
FY05: 559 (7 sites)
FY04: 417 (5 sites)
FY03: 455 (4 sites)

Estimated Cost Per Student:
FY05: $519; FY04: $480; FY03: $374

Growth Trajectory: Starting in 1993, the scope of the UNITE program was expanded to freshmen and sophomores in high school, thereby identifying and supporting students throughout their four years of high school. JETS has been contractor for 20+ years. According to the contractor, during 1980s the Army considered cutting funding for UNITE; however JETS and the university sites lobbied Congress heavily and Army funding was retained.

❑ Brief Program Description:

UNITE aims to promote careers in engineering and technology at the high school level by providing students access to academic enrichment courses on college campuses. UNITE is designed to provide historically under-represented (socially/economically disadvantaged) high school students with summer class instruction that closely parallels that of a first-year student in a university engineering program. Through academic classes, hand-on activities, and team-based learning, the students explore the connections between math and science, and real world applications. Students also make visits to STEM organizations, including nearby Army installations (or other service branches if no Army location). A member of the ROTC addresses each site.

❑ Program Goals and Objectives

- Provide historically under-represented (socially/economically disadvantaged) high school students summer class instruction that closely parallels that of a first-year student in a university engineering program.
- Provide opportunity for exploration of the connections between math and science, and real world applications through academic classes, hand-on activities, and team-based learning
- Promote careers in engineering and technology at the high school level.

❑ **Program Promotion Methods and Responsibility:**

The contractor, JETS, has responsibility for national promotion; although it is unclear how valuable this is, given the requirements for university participation and the funding constraints. The promotion consists primarily of a page on the JETS website has one page; although currently no link to the AEOP website and some literature and pamphlets.

The Army's role is primarily information, included on the ARO and ARL and AEOP websites.

Individual university sites have responsibility for local promotion; although a brief search of selected university websites yielded little or no information: there is no listing on the University of New Orleans' website (either under the prospective student or science or engineering department sections; nor with a request in the university's search engine); the University of Detroit includes the UNITE logo on the bottom of its "internships" page, but not in the sidebar menu list of over 15 programs.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation:

- Grantee and site coordinators do follow-up assessments in standard format.
- Can dismiss and/or add other sites – seems to occur as result of numbers of students that university attracts annually: CO State supplanted Clarkson 3 years ago b/c Clarkson didn't maintain numbers. CO now may lose funds b/c such a small site (~20 students), and because there is suggestion to add CO funds to New Orleans b/c of pressures from Hurricane Katrina and b/c New Orleans does a great job with program.
- University sites chosen by virtue of being in the "heart" of the targeted population

Current program metrics:

- Annual number of students
- Percentage of enrolled students (75% are enrolled in or have attended college)
- Percentage of enrolled/graduates who maintain interest in STEM: 53% of participants who are in or have graduated from college have remained in the STEM disciplines.

The JETS contractor commented that JETS was in process of re-evaluating each stage of the program to consider outcomes and how the program could be more effective.

❑ **Strengths and Challenges**

UNITE only provides funds for programs that already exist; a potential site cannot use funds to start a new program. There is apparently some attention to the performance of individual sites, but only one instance of a site losing funding. It is not clear whether or not these sites were chosen from a larger pool of "applicants" at the beginning of program (20+ years ago), and/or whether other university sites in economically disadvantaged areas have expressed interest in participating.

The program is very limited in its geographical focus and (apparently) in its ability to expand. While the outcomes in terms of subsequent college attendance and continued interest in STEM, the per student cost appears to be somewhat high, relative to the fact that the program must already be in place.

It also is not clear what the Army gains from "owning" a separate program with attendant overhead. If the locations, universities and/or their programs are worthwhile, it may make more sense to fund the program directly, with the same level of Army branding and Army ROTC or lab visits.

The program is not well known and has no distinguishing characteristics that link it to the Army research enterprise; for this reason, there is no internal awareness of the program. Direct experience with any Army personnel or location appears to be irregular and, in cases in which there is no nearby Army facility, the connection may be to another one of the services. The contractor is a nonprofit organization with a number of functions and responsibilities and UNITE is only one among a number of programs that it promotes.

UNITE shares characteristics with both REAP – without the size or high achiever aspect – and GEMS – without the carefully developed and detailed structure of the experience, not to mention the focused attention of the GEMS founders. Because of its relative isolation from other AEOP programs, UNITE doesn't appear to offer an easy option as a pathway to other AEOP programs.

❑ Program Recommendations

- Meet with the contractor to discuss strategies for increased effectiveness and reach.
- Benchmark content, student participation, student satisfaction and cost against similar programs.
- Evaluate the performance of current university sites, according to outreach, promotion, student satisfaction, number of high schools reached, etc. as well as subsequent student education track.
- Publish a new RFP for application to UNITE, including current sites and potential new sites.
- Review management costs of contractor and universities.

❑ Recommended Additional Metrics

- Student satisfaction through pre and post testing
- Student learning via pre and post testing
- Student awareness of career options in Army and military and its contractors

❑ Program Overview

Date established: Summer Institutes – 1989; Service Academy Internships - 1998

Lead Army Organization: ARL HPCRC

Management Structure: Army lab personnel oversee the program, which is managed by participating university and/or Army lab. The program is headquartered at the University of Minnesota.

Participating Organizations/Locations: The AHPCRC partners include: Clark Atlanta, Florida A&M, Howard, and Jackson State Universities; the University of Minnesota; the University of North Dakota; and Network Computing Services, Inc. Four of these universities are HCBU/MI, with their participation funded using the Army's 10% set aside.

Annual Budget:
The Army funds the program, with major equipment acquisition provided by DoD's HPC Modernization Program.
HPCRC: $1.5M

Summer Institute (15 high school students for 2 weeks): at university - $50K per university or $300,000 total.
Advanced Summer Institute:
Service Academy Internship Program (military academy cadets for 3 weeks): at HPCRC labs.

Target student population:
Summer Institute: ~950 high school students competing for 15 slots*;*
Advanced Summer Institute: 15-20 undergraduate students for 10-weeks program + $3500 stipend.

Student selection: By individual application to the university or ARL HPC lab.

Number of Students Served:
Summer Institute: no totals available; number of participating universities varied by year.
Advanced Summer Institute: 212 (1991-2002)
Service Academy Internship Program: 2005 - 11; 2004 – 5; 2003 – 2.

Number of Teachers Involved: No information

Number of Adult Leaders: N/A

Cost per student:
Summer Institute: ~15 students @ $50K/university: $3,333
[dollar figure includes informal teacher participation, in some cases]

Growth Trajectory:
Program manager at one lab commented that could probably double the number of sites, but at that point would reach the capacity.

- **Brief Program Description:**

The AHPCRC is a government-university-industry partnership committed to helping maintain the Army and United States lead in HPC research, and providing future generations with the advanced tools and training they will need. The educational programs of the AHPCRC are designed to emphasize the use of HPC in research and its application to complex real-world problems. Through such programs, including its high school and undergraduate summer institutes, as well as its graduate research opportunities, students are encouraged to pursue advanced degrees focusing on computational sciences and engineering. The AHPCRC provides three types of internships designed to interest students – especially women and underrepresented minorities – in STEM and encourage them to consider careers in STEM research.

The ***Summer Institute*** is a two-week experience at a university site for approximately 15 students. The program is quite competitive, with approximately 950 applicants for 15 slots. The cost is $50K per university. The curriculum is the same across all universities for the first week; the second week, the curriculum is customized to the particular research focus of the university.

The ***Advanced Summer Institute*** hosts 15-20 undergraduate students for a 10-week program, which emphasizes the use of simulation and modeling, parallel computing, and graphics and visualization to solve real-world problems of interest to the Army. The Institute's purpose is not only to train students in these areas, but also to encourage them, especially women and minorities, to pursue graduate studies or careers in HPC. The Institute includes a $3500 stipend.

The ***Service Academy Internship Program*** is a three-week program, which offers military academy cadets participation in research projects taking place at the AHPCRC. Cadets work closely with AHPCRC staff scientists and other researchers in diverse areas such as computational fluid dynamics, computational solid mechanics, and computational chemistry. Students are trained in the use of high performance computing resources and numerical simulation tools, and then perform numerical simulations and analysis on engineering applications, which are relevant to the U.S. Army and the Department of Defense.

- **Program Goals and Objectives**

The educational programs of the AHPCRC are designed to emphasize the use of HPC in research and its application to complex real-world problems. Through such programs, including its high school and undergraduate summer institutes, as well as its graduate research opportunities, students are encouraged to pursue advanced degrees focusing on computational sciences and engineering.

Summer Institute: To interest students – especially women and underrepresented minorities – in STEM and encourage them to consider careers in STEM research.

Advanced Summer Institute: To train students in these areas and also to encourage them, especially women and minorities, to pursue graduate studies or careers in HPC.
The *Service Academy Internship Program*: Students are trained in the use of High Performance Computing resources and numerical simulation tools, and then perform numerical simulations and analysis on engineering applications which are relevant to the US Army and the Department of Defense.

"Teach the teacher": 2 week program for high school teachers, inaugurated in 2003 in Minneapolis and Aberdeen. The program provides teacher modules (such as cds and instructional material) that fit high school curriculum; as well as offering hands-on experience. They are then more able to "teach the teacher".

- **Program Promotion Methods and Responsibility:**

Summer Institute and Advanced Summer Institute: Universities promote to local schools and geographically eligible colleges/universities

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation:
Numbers of students for each program;
Data tracking for *Advanced Summer Institute* undergraduates:
Between 1991-2002 there have been 212 students. The program has data from 93 of them: 18 have gone on to study math; 14 to engineering; about 14 have gone to work for DOD or a government contractor.
Of the 93, 18 (35%) are African American; 10 are white; 4 Asian, not Hispanic.

Current program metric:
Numbers of student applicants
Advanced Summer Institute: Numbers of students who go on to study STEM and take jobs in DOD or government contractor.

- **Strengths and Challenges**

Anecdotal information that includes written and video material on student projects and participation suggests that each program is successful, but they are resource intensive and only the *Service Academy Internship* program is connected to Army labs.

Summer Institute: It is not clear whether or to what extent this program is successful, given that the goal does not require formal submissions by students, is primarily designed to "interest" students in STEM, and is restricted in tracking students at this age.

Advanced Summer Institute: The faculty work with these undergraduate and graduate students to interest them in going on – encourage them to get internship at Army lab the next summer, etc.

Service Academy Summer Internship: For those students who complete the program, there are additional research internship opportunities working one on one with scientists at Army labs or at Cray, Inc.

- **Program Recommendations:**

The overall recommendation here is to develop ways to reduce cost per student:

- Investigate the possibility of standardizing the week one "common" curriculum so that it may be used more than one year.

The high cost per student - over $3,000 – includes the curriculum, both the common curriculum developed for use by all universities in week one, and the curriculum customized to individual university capabilities for week two, changes from year to year and therefore the cost cannot achieve cost savings over time.

- Explore costs of university management, with a view to possible savings by collaboration on promotion materials or other aspects.
- Consider the impact on student application and participation in the Advanced Summer Institute if the $3500 stipend were reduced.

- **Recommended Metrics: N/A**

RESEARCH AND ENGINEERING APPRENTICE PROGRAM (REAP)

❑ Program Overview

Date established: 1979

Lead Army Organization: Army Research Office/Youth Science Programs

Management Structure: Oversight by Army program manager, with organization and management provided by external contractor, the Academy of Applied Science

Participating Organizations/Locations: 54 colleges/universities

❑ *Annual Budget:*

FY03: Total - $340,000; Student awards - $247,000; Administration - $93,000
FY 04: Total - $352,000; Student awards - $247,000; Administration - $105,000

The Army's budget provides a $2600 stipend for each student, totaling 95 grants per year. Universities waive overhead. Most of the participating universities receive funding for one student stipend; although a few have two students. In the absence of additional funds for stipends, adding a new university requires transferring a student slot from a university with two.

Target student population: High school seniors, rising seniors and rising juniors in historically underrepresented groups

Student selection:

The basic criterion for selection of participants is the potential shown for pursuing careers in science and engineering. Factors considered in the selection process include:

- previously demonstrated abilities and interests in science and engineering;
- potential for a successful career in the field as indicated from overall scholastic achievement, aptitude and interest areas
- recommendations from high school teachers and/or administrative personnel
- interviews with prospective participants
- residence within daily commuting distance of the work; although sponsors/universities are free to provide special transportation within legal limits.

University selection:
The contractor (AAS) identifies and evaluates current and prospective sponsoring university institutions and mentors, and selects those that can provide the best opportunity to ensure program success. An institution may be awarded more than one grant and, accordingly, a mentor may oversee more than one apprentice.

Number of students served:
FY03: 138
FY04: 104
Universities and other organizations are free to raise additional funds for students to participate in the program, so the totals are greater than the 95 students funded by the Army.

Administrative Cost per Student:
FY03: $978.95
FY04: $1,105.26

Growth Trajectory:

The number of students applying has increased over years; although the majority of the participating universities has not changed. Three universities were added in 2005/6, as a result of unsolicited inquiries. One had previously been a REAP site.
The initial list of universities was those with Army programs; now they must be Army contractors (individual researchers/mentors don't need to be contractor, however). Expanding the number of participating universities would require a zero-based RFP promoted to a broader pool of universities (without additional program funds).

- **Brief Program Description:**

REAP provides underrepresented high school students interested in science and engineering the opportunity to participate as apprentices in summer cooperative work-study and research programs in university labs. The apprenticeship includes hands-on experience in research and development activities.

High school students accepted for apprenticeships are be paid during work periods and work directly under a mentor scientist or engineer, who provides guidance on day-to-day job activities, as well as assisting in providing information on career opportunities in science and engineering. The mentor has the discretion to use his/her portion of the grant funds to pay other research assistants for services rendered in accomplishing the program.

Although designed primarily as a summer program, once the student is brought into the program, his/her progress and association with the sponsoring institution will be encouraged on a continuing basis, hopefully through college as he/she becomes eligible for other programs such as co-ops or internships. The program at the institution may be continued through the winter as an after-school job to ensure that the apprentice's motivation is maintained.

- **Program Goals and Objectives**

The ultimate REAP objective is to ensure the availability and improve the quality of people who are qualified and oriented to perform professional and support work in defense life and physical sciences, by:

- Providing a cooperative education (work/study) program of mentor/apprentice sciences interaction for high school students who are historically under represented in the science, mathematics, engineering and technology fields;
- Offering hands-on experience in research and development activities to students to encourage their continued education in the science, mathematics, engineering and technology fields;
- Exposing students to science experience not readily available in high school;
- Providing the students an opportunity to work cooperatively with scientists actively engaged in research.

- **Program Promotion Methods and Responsibility:**

Contractor Promotion to Universities:
REAP is advertised through website, pamphlets, presentations, conferences.
The contractor provides pamphlets, brochures, fact sheets, and its newspaper
According to the contractor, because the number of grants is static, AAS is not allowed to promote the program beyond existing universities; although universities occasionally approach the contractor with requests to participate.

Universities Promotion to High Schools:
Universities typically develop and maintain relationships with area high schools through letters to the school science teachers and guidance counselors, who return applications of interested students.
[Survey sample demonstrates range in locations: "2005: 103 applications from different high schools"; serving ten or more schools that are within driving distance of the university

- **Data/Outcomes/Other metrics:**

Formal or informal evaluation: Annual summary evaluation developed from mentors and university site coordinators; the summary for FY05 not yet available.

Within thirty (30) days after conclusion of the apprenticeship, the mentor submits to the university a narrative letter report on each student employed as part of this program. The report must indicate the type and level of work performed by the student and an evaluation of the student's performance as well as comments and suggestions on this effort.

Current program metrics:
Number of students who enter college and remain in science, mathematics, engineering and technology disciplines. Approximately 90 percent of REAP participants go on to pursue further education in science, mathematics, engineering, and technology disciplines

Qualitative metrics:
Note: The AEOP program manager for REAP sent a survey to each of the university contacts with request for written responses from which 9 were received and tallied. Some of the pertinent comments follow:

Comment from one survey respondent:
Each student has expressed a deep appreciation for the exposure to the university environment. Apprentices from the 2004 program have since enrolled at the university, one in the host department (chemistry).

In addition to "satisfaction" measures, about 1/3 of the sample of 9 university surveys noted additional "performance assessment" measures, including:
- ✓ students must create end products; these products have been papers and oral presentations
- ✓ students and their advisors to make a presentation about their projects. This year I will suggest them to come back in March for a University-wide research conference.
- ✓ I view the project as successful when it reaches the stage at which a refereed research publication results.

❑ Strengths and Challenges

REAP is well-established and known among the universities and high schools that participate; although the contractor believes that Army personnel – even in locations near the universities – do not participate in any aspect of the program, and apparently have little awareness of it.

The hallmark of this program is the one-on-one mentor component, and the program states detailed requirements for mentor's responsibilities. The decision on mentors is left to the university, which a request to provide guidelines to all sponsors and mentors to maximize use of time of the apprentice's time. It is not clear, however, how effective the mentor relationship is, given the lack of data from university program managers about the individual mentors. There also is no data available about whether the mentors remain the same year after year, are evaluated regularly via student "exit" surveys/interviews, or receive any training/guidance in their first few years of serving as a mentor.

Although designed primarily as a summer program, once the student is brought into the program, the program guidelines recommend that "his/her progress and association with the sponsoring institution be encouraged on a continuing basis, hopefully through college as he/she becomes eligible for other programs such as co-ops or internships." Anecdotal evidence from several survey respondents note individual cases of such continuation into degree programs. The program at the institution may be continued through the winter as an after-school job to ensure that the apprentice's motivation is maintained.

❑ Program Recommendations:

Review and revise, as necessary, criteria and evaluation for university participation:
- Review evaluation process, including existing templates and value of additional criteria and pre/post interviews with students about expectations and realities of the experience. Stipulate to universities that evaluations must be completed in requisite detail in order to remain in good standing.
- Develop list of optimum pool of potential universities, without regard to current participants, in order to determine if there are universities with significant presence and influence among under-represented populations that are not aware of REAP and that are eligible for inclusion.

Solicit recommendations from university POCs, mentors, and students (to the degree this is feasible) for improvements in the effectiveness and efficiency of the program.

- Develop and promote process and materials that existing REAP universities and potential REAP universities can use to solicit funds from business and/or other funding organizations to support additional apprentices.

Increase Awareness of REAP among Army personnel and develop methods to expand the Army branding of the program, particularly among students:

- Request that appropriate Army personnel sign the "welcome" and "congratulations" letters that are sent to each student by the contractor.
- Enclose information on Army R&D and potential careers in these mailings.
- Institute personal communication to Army locations that are within commuting distance to participating universities, to encourage at least one visit by Army personnel to the university lab to meet student and mentor.
- Develop a fact sheet about REAP for distribution to contiguous Army locations (and for inclusion in potential AEOP "joint marketing" packet, that includes data on the subsequent degree and career choices of individual students.

Develop suggested "career path" options for REAP students among AEOP and related education programs:

- Request exchange of information between Army-supported university R&D - UARCS, Centers of Excellence, Collaborative Technology Alliances, and other HBCU/MI universities that have relationships with Army installations – and REAP to consider potential collaboration in terms of providing opportunities for students who complete REAP.

- Make connections between JSHS and REAP explicit. Several programs are in same universities as JSHS, and some of the REAP students have gone on to JSHS

❑ **Recommended Metrics:**

- Numbers of students whose subsequent interest in STEM is encouraged by participation in REAP.

- Numbers of high schools that are involved in REAP outreach.

- Degree of engagement of community, in terms of potential business or private sector funding for additional students.

CONSORTIUM OF UNIVERSITIES OF THE WASHINGTON METROPOLITAN AREA (CUWMA)

❑ Program Overview

Date established: 1981 by ARI and the Consortium

Lead Army Organization: Army Research Institute

Management Structure: CUWMA is managed by a full-time Consortium Director, who is a contract employee. The Consortium Director is supported by two additional full-time contract employees.

Participating Organizations: 5

Locations: 16

Army Research Institute—9 locations: Arlington, VA; Ft. Knox, KY; Boise, ID; Ft. Bragg, NC; Suffolk, VA; Ft. Leavenworth, KS; Ft. Benning, GA; Ft. Rucker, AL; and Orlando, FL.
Defense Manpower Data Center—2 locations: Rosslyn, VA and Seaside, CA
National Defense University, Ft. McNair, Washington, DC
Air Force Research Laboratory—3 locations: Wright-Patterson AFB, Ohio; Mesa, AZ; and San Antonio, TX
Office of the Under Secretary of Defense (Personnel and Readiness), Arlington, VA

Participating Universities Include:

American University
The Catholic University of America
Gallaudet University
George Mason University
The George Washington University
Georgetown University
Howard University
Joint Military Intelligence College
Marymount University
National Defense University
Southeastern University
Trinity College
University of the District of Columbia
University of Maryland, College Park

Annual Budget:
FY 2004: $1,539,000
FY 2005: $2,027.000 (as of August 25, 2005)

Target student population:

- Graduate and undergraduate students enrolled in degree-granting programs in information technology, and the social, behavioral and computer sciences.
- Several HBCU/MIs participate in the program, and approximately 24% of students who have completed the program are minorities.
- Students must be U.S. citizens.

Student selection:

- Interested students may apply at any time by submitting a cover letter, current resume' and two letters of recommendation from faculty. Students must be enrolled in a degree program, in good academic standing.
- After screening by the Consortium Director, candidates are interviewed and selected by prospective mentors.

Number of Students Served:

- ***Overall program:*** The program has served 1005 students over its 25 year history.
  Currently on Board (2006): 110 Research Fellows

- ***At ARI:***

Number of students:	45 in 2006
Number of mentors:	34 (as of August 2005)
Number of faculty:	19
ARI Locations:	8
Number of universities:	27 in FY 2004

Cost Per Student:
FY 2004: $32,000
FY 2005: $33,000

Growth Trajectory: CUWMA is a mature program, which appears to have experienced modest growth in recent years.

❑ **Brief Program Description:**

The Consortium Research Fellows Program at ARI is open to graduate and undergraduate students enrolled in degree-granting programs in information technology, and the social, and behavioral sciences. Each research fellow is assigned to a government mentor. The research fellows perform a variety of technical and analytical duties, such as literature reviews, design and/or administration of survey instruments, data collection and analysis, and preparation of research reports. Each fellow's schedule is flexible, and is worked out individually between student and mentor. Fellows may work up to 20 hours per week during the school year and 40 hours per week in the summer. Work sites are in Arlington VA and a number of field elements across the country.

There are four types of research fellows:

- **Consortium Research Fellows** (graduate students) are placed on research teams at sponsoring agencies to provide technical and analytical support while receiving training and experience in the theory and practice of their chosen future professions.

- **Consortium Research Assistants** (undergraduate students) function similar to fellows but are given less demanding tasks and more guidance.

- **Post-Doctoral Fellows** (full-time recent Ph.D.s) work full time for one or two years on specific projects for ARI.

- **Senior Consortium Research Fellows** (faculty consultants) complete short-term, task-specific research for sponsors.

Fellowship appointments are for a minimum of one year and a maximum of three years. Fellows earn between $16,445 and $33,345 per year for up to 1,300 hours of service.

❑ **Program Goals and Objectives**

- Provide educationally-relevant professional research experiences for undergraduate and graduate students.

- Provide high-quality technical and analytical support to sponsoring agencies.

- Groom a new generation of scientists, who either directly as government employees, or indirectly as contractors, will support Department of Defense R&D in the future.

- Provide research opportunities for faculty.

- Encourage fellows to complete their undergraduate and graduate degrees.

❑ **Program Promotion Methods and Responsibility:**

ARI has responsibility for promoting the Consortium Research Fellows Program. The program is promoted through the AEOP web site, through the CUWMA web site (www.consortium.org), and through web site links to all participating colleges and universities. Brochures and fact sheets for CRFP also are distributed by participating universities.

CUWMA also has long-term relationships with individual faculty members, many of whom recommend students year after year. In addition, the Consortium fellows we interviewed told us that some of their universities (for example, George Mason) have a strong and established network through which the students share information about opportunities among themselves. At other universities, such as Howard, awareness of ARI opportunities is more limited.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics: (Currently tracked informally)

- Number of Consortium students completing advanced degrees.
- Number of Consortium students joining ARI as researchers.
- Number of Consortium students entering government service.
- Number of Consortium students jointly publishing articles and papers with ARI researchers.
- Of the 1005 students who have participated since 1981, approximately 90% have completed their degrees.
- 18 Research Fellows have been hired by ARI.

❑ **Strengths and Challenges**

The Consortium program is strong overall, and well-adapted to ARI's recruitment and research needs. The program seems to be effective at creating win-win opportunities for student participants, individual ARI researchers, and the institution as a whole. The program also is having an impact, with 18 former fellows working at ARI, a number of others electing government service, and most fellows completing advanced degrees. While it is impossible to determine conclusively that that program was the cause for this record of degree completion (as opposed to attracting serious students who were already on track to complete advanced degrees), the record is nevertheless impressive.

Some of the key strengths include:

Content: The Consortium fellows seem to be presented with challenging content, based on real-world Army research. Many students publish their results jointly with Army researchers, and accomplish their Master's thesis or doctoral dissertation using research performed during their fellowship. Importantly, most of the mentors we interviewed felt strongly that the students make an extremely valuable substantive contributions to their work.

Personalization and Engagement: Participating students have the opportunity to perform in-depth work under the guidance of experts in the field. According to the students, the relationships with the mentors are outstanding overall. There have been a few mentors over the years who are inattentive to their students or difficult to work with, and students have voted against those mentors with their feet, and shifted to other mentors.

Dosage/Duration: The continuity of relationships with fellows—which may last up to three years—is a key strength of CUWMA. The high number of students who return annually demonstrates that the students value the mentoring and research opportunities.

A key reason for the success is no doubt the work of Dr. Robert Ruskin, who works overtime to develop relationships at feeder universities that ensure a flow of quality students into the program, as well as to find the right match of student and mentor, and to oversee that day to day mentor/fellow relationships to ensure they are running smoothly. However, this also could put the future of the program at risk, as the current success and impact of the program, as well as the entire knowledge base of how the program runs, rests with him.

❑ Program Recommendations

Broaden Recruitment Efforts at Participating Universities. Currently, students are recruited largely as a result of long-standing personal relationships between the Consortium Director and individual faculty members at participating universities. Many of the participating students told us they learn of the program through word of mouth, and that some participating universities are much better than others at getting the word out. Procedures should be put in place at participating universities to reach out to a larger pool of students in order to attract the best applicants.

Create More Transparent Eligibility Requirements. CUWMA's requirements that students be enrolled and in good standing are vague, and seem to leave a lot of discretion to referring faculty, the Consortium Director and participating mentors. The Army might consider creating and advertising clearer eligibility requirements, and creating a more transparent process for application and acceptance.

❑ Recommended Goals

- Encourage high potential students to persist in STEM studies.
- Encourage high potential students to pursue STEM degree completion.
- Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
- Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

❑ Recommended Metrics

- Number of Consortium fellows graduating with a science or engineering degree.
- Number of Consortium fellows joining ARI as researchers.
- Number of Consortium fellows who become Army employees, military scientists or engineers.
- Number of Consortium fellows entering public service.

CAREER-RELATED EXPERIENCE IN SCIENCE AND TECHNOLOGY (CREST)

❑ Program Overview

Date established: Established as a pilot project in 1997.

Lead Army Organization: Research Development and Engineering Command (RDECOM)

Management Structure: The program is managed internally by one of RDECOM's human resources divisions.

Participating Organizations/Locations: 10

Natick, MA
Aberdeen Proving Ground, MD
Rock Island, IL
Ft. Monmouth, NJ
Warren, MI
Huntsville, AL
Orlando, FL
Army Research Lab, Adelphi
Picatinny Arsenal, MJ
Ft. Belvoir, MD

Annual Budget: $175,000-$200,000

Target student population:

- Undergraduate and masters' level students with majors in engineering, mathematics or computer science.

Student selection:

- Applicants must be enrolled as full-time students in good standing.
- Applicants must be U.S. citizens, and successfully complete a background investigation to obtain a secret security clearance.
- Applicants must major in a field of engineering, mathematics or computer science for which the Army is recruiting.
- Undergraduate students must successfully complete their years with a minimum GPA of 2.5.
- Graduate students must be accepted into graduate school and starting the first year of graduate study.
- Students must be capable of arranging a work schedule in such a way that a minimum of 640 hours of work at Army facilities is achieved prior to degree completion.
- Students must be prepared to accept conversion to an Army Internship within 120 days after degree completion.

Number of Students Served: 44 students currently enrolled. 600-700 students have participated over the past 10 years.

Administrative Cost Per Student(2005): No direct costs because managed within the human resources department's base workload.

Growth Trajectory: This is a steady-state program.

❑ Brief Program Description:

CREST is a program to recruit student engineers and scientists as future leaders in areas of military importance by providing summer and part-time employment (to include employment during school breaks), and an opportunity for an engineer or scientist position in the Army Intern Program.

Each full-time student is provided with an Army sponsor who works with the student to develop a work experience in each student's area of expertise, which will not interfere with that student's academic performance. Each Army sponsor serves as a mentor, establishes personalized objectives with the student, and reviews the student's performance annually.
CREST utilizes the government-wide Student Career Experience Program (SCEP), which provides a flexible authority under which students can be hired into positions that are related to their academic fields of study. Students enrolled or accepted for enrollment as a degree-seeking student in an accredited high school, technical or vocation school, 2-year or 4-year college or university, or graduate or professional school are eligible for the program. Participants who successfully complete their coursework leading to a diploma, certificate or degree, and who successfully perform at least 640 hours of work, may be non-competitively converted to term, career, or career-oriented positions.

❑ **Program Goals and Objectives**

- Meaningful engineering and scientific work experiences at Army research, development and engineering centers or related organizations.
- Work experiences are directly related to students' career goals.
- To provide an opportunity for direct conversion to a position in the Army Intern Program upon completion of a Bachelor or Master of Science degree.
- Progression to a position as an Army Engineer or Scientist with successful completion of the Intern Program.

❑ **Program Promotion Methods and Responsibility:**

The program is promoted through the AEOP web site and the RDECOM web site.

❑ **Data/Outcomes/Other Metrics:**

- ***Formal or informal evaluation:*** None provided.
- ***Current program metrics:*** None provided.

❑ **Program Recommendations**

Consider Broader Use of SCEP Authority. CREST is one of several programs directed toward creating positive work experiences for undergraduate and masters-level students. The program is the only one in the AEOP portfolio, however, that utilizes the government-wide SCEP authority. SCEP is a very flexible and versatile authority that enables students of all levels—high school, undergraduate and graduate students—to participate in meaningful work experiences on a part-time basis during the academic year. Successful students can be offered non-competitive conversion to full-time positions. Broader use of this authority might create more flexibility and benefit in some of the other programs.

❑ **Recommended Goals**

- Encourage high potential students to persist in STEM studies.
- Encourage high potential students to pursue STEM degree completion.
- Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
- Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

❑ **Recommended Metrics**

- Number of CREST students completing undergraduate-level degrees in science, engineering or mathematics.
- Number of CREST students completing masters and graduate-level degrees.
- Number of CREST students who become Army interns.
- Number of CREST students who become Army employees, or military scientists or engineers.
- Number of CREST students entering public service.

SCIENCE & TECHNOLOGY ACADEMIC RECOGNITION SYSTEM (STARS)

❑ Program Overview

Date established: 1997

Lead Army Organization: Army Research Laboratory (ARL)

Management Structure: Managed by ARL employees.

Participating Locations: 6

Adelphi, MD
Aberdeen Proving Ground, MD
Research Triangle Park, NC
White Sands Missile Range, New Mexico
Cleveland, OH
Langley, VA

Annual Budget: $400,000 committed at program's peak.

Target student population:

- Undergraduate seniors in good standing at Historically Black Colleges or Universities or other Minority Institutions.

Student selection:

- Applicants must be U.S. citizens.
- Applicants must be enrolled in a fully accredited higher education institution which is a Historically Black College or University or other Minority Institution.
- Applicants must be classified as a senior at the end of the semester for which he or she applies to the program.
- Applicants must have a grade point average of 3.0 or higher on a 4.0 scale at the time of the application.
- Continued participation in STARS requires students to maintain a 3.0 grade point average during the entire period of enrollment in the program, and to receive satisfactory performance reviews for all periods when the student is working under the guidance of an ARL mentor.

Number of Students Served: 27 students have served as fellows since 1997.

Administrative Cost Per Student(2005): Not provided.

Growth Trajectory: STARS is a steady-state program.

❑ Brief Program Description:

The Army Research Laboratory (ARL) STARS program was designed to assist ARL with maintaining a world class team of scientists and engineers with advanced degrees in highly competitive research areas, while simultaneously continuing to enhance the diversity of the ARL professional team. The STARS program helps to identify and recruit exceptional students that are enrolled in a science, engineering, or mathematics curriculum at Historically Black Colleges or Universities and/or other Minority Institutions (HBCU/MIs).

Students participating in the STARS program receive tuition assistance and a paid-internship as they progress professionally within the ARL workforce. Students in the STARS program will receive up to $30,000 per year for two years of their graduate study. During the summer, students are given the opportunity to work with an ARL research team on career-related projects of technical relevance to the ARL mission. Each student enters into a mentor/protégé relationship with an ARL senior research scientist, who will assist in the student's professional development.
Successful completion of the program may lead to a career-conditional position within ARL.

- **Program Goals and Objectives**

  - The overall objective of the STARS program is to alleviate the projected future shortfall of graduate (Master's) level scientists and engineers by targeting the underutilized groups of students at HBCU/MIs.

- **Program Promotion Methods and Responsibility:**

The program is promoted through the AEOP web site and the ARL web site, through ARL's Educational Partnership Agreements, and through attendance at career fairs and conferences.

- **Data/Outcomes/Other Metrics:**

  - ***Formal or informal evaluation:*** None available.

  - ***Current program metrics:***

  - Of the 27 students who have participated in STARS since 1997, 14 completed graduate science, mathematics or engineering degrees.

  - 10 former STARS fellows remain in government employment.

- **Recommended Goals**

  - Encourage high potential students from under-represented groups to persist in masters and graduate-level STEM studies.
  - Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
  - Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

- **Recommended Metrics**

  - Number of STARS students completing masters and graduate-level degrees in science, mathematics or engineering.
  - Number of STARS students who become employees of the Army, or Army academic and contractor partners.
  - Number of STARS students entering public service.

FACULTY RESEARCH AND ENGINEERING PROGRAM (FREP)

❑ Program Overview

Date established: Unclear. Likely during the 1970s.

Lead Army Organization: ARL—Army Research Office

Management Structure: Oversight by an ARL employee, with administrative functions and support provided by Battelle, Chapel Hill Operations.

Participating Army Organizations (2005): 4

Army Research Lab—APG: 3 Faculty members
ARL—Adelphi: 1 Faculty member
Ft. Sam Houston: 1 Faculty member
Ft. Rucker: 1 Faculty member

Participating Universities: 6

Michigan Tech
University of Texas
Purdue University
Catholic University
Texas A&M Kingsville
Alabama A&M

Annual Budget (2005): $144,613, paid for by the individual Army investigators who sponsor the faculty members.

Target population:

- U.S. citizens who are faculty members working at an American college, university, or technical institution as a full, associate, or assistant professor.

Participant selection:

Government organizations prepare and post Statements of Work for projects on which they are interested in receiving assistance. Interested professors complete an online application, and submit it, along with a current resume. Qualified faculty are selected and paid by the sponsoring organization.

Number of Faculty Served (2005): 7

Cost Per Faculty Member (2005): $20,659

Growth Trajectory: Utilization of the program has declined significantly in recent years. A decade ago, the average annual participation was at least 30 faculty members annually.

❑ Brief Program Description:

FREP offers university and college professors opportunities to collaborate with government scientists on short term technical projects at government laboratories at any time during the year. A research effort of up to 60 working days may be planned over the course of a one-year period of performance. FREP also allows for the location of the research effort be split between the government lab and the faculty member's home office.

Sponsoring organizations develop Statements of Work, for which qualified faculty apply. ARO (through its Scientific Services Program) negotiates a cost proposal and sends it to ARO for award. Work may commence once ARO awards the task.

The daily rate for FREP participants is based on a graduated schedule: Assistant Professors--$250 per day; Associate Professors--$290 per day; Full Professors--$330 per day. In addition, travel expenses to and from the laboratory and per diem are reimbursed in accordance with the current Federal Travel Regulations.

A final report is the end product of the effort.

- **Program Goals and Objectives**

  - To advance government scientific and engineering research, and provide university faculty with a hands-on experience in a government laboratory.

- **Program Promotion Methods and Responsibility:**

HSSMFP is promoted through the Army Research Office web site, the Army's AEOP web site, and word of mouth. All projects must be initiated by the government sponsor.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics: None available.

- **Strengths and Challenges**

This is a small program, which appears available to supplement a variety of other authorities under which laboratories may host college or university faculty at Army laboratories to engage in collaborative research. Currently, FREP seems to be used to fund projects of interest to an individual researcher and faculty member that may not fit under other authorities (such as ongoing programs of research through a Center of Excellence or Collaborative Technology Alliance, in which university faculty routinely work at Army laboratories).

- **Program Recommendation**

Eliminate Program from AEOP Portfolio or Restructure to Link Directly to AEOP-Branded Programs. Clearly, creating research opportunities for faculty to perform hands-on research in an Army laboratory is an important way to familiarize them with Army research, and military science career opportunities that may be available to their students. This experience no doubt would make these faculty more knowledgeable and effective advocates for Army research and programs. However, there currently appears to be no linkage between these activities and any STEM education programs the Army sponsors for undergraduate students (such as CQL or the Army Intern Program).

Because individual investigators fund the salaries of the faculty they sponsor (plus a 6% processing fee charged by ARO), additional funding would be required if the Army were to offer research experiences to faculty who support AEOP programs. Given other program priorities, devoting funds for this purposed cannot be a top Army priority. Should adequate resources become available, the Army should use the FREP authorities to create close linkages to the Army's student internship programs.

ARMY HIGH SCHOOL SCIENCE AND MATHEMATICS FACULTY PROGRAM (HSSMFP)

❑ Program Overview

Date established: Unclear. Likely during the 1970s.

Lead Army Organization: ARL—Army Research Office

Management Structure: Oversight by an Army employee, with administrative functions and support by Battelle, Chapel Hill Operations.

Participating Organizations/Locations (2005): 5

Natick Soldier Center (NSC): 3 teachers
Tank Automotive Research Development and Engineering Center (TARDEC): 1 teacher
Army Medical Research Institute of Infectious Diseases (AMRIID): 1 teacher
Walter Reed Army Institute of Research (WRAIR): 1 teacher
Engineer Research and Development Center (ERDC): 1 teacher

Annual Budget (2005): $64,050, paid for by the individual Army investigators who sponsor the teachers.

Target population:

- U.S. citizens who are faculty members of accredited high schools or secondary schools from the 7th to 12th grades and teach in one or more of the following disciplines: mathematics, physics, general science, engineering, chemistry, psychology, computer science or biology.

Participant selection:

Interested teachers complete an online application, and submit it, along with a current resume. Qualified teachers are selected and paid by the sponsoring organization.

Number of Teachers Served (2005): 7

Cost Per Teacher (2005): $9,150

Growth Trajectory: Utilization of the program has declined significantly in recent years. A decade ago, the average annual participation was at least 30 teachers annually.

❑ Brief Program Description:

ARO has established an expedited and flexible contracting process to allow laboratories to host high school teachers over the summer or during the school year. Sponsoring organizations develop Statements of Work, for which teachers apply. ARO (through its Scientific Services Program) negotiates with the teacher, and awards a task order.

The work may be in any area of interest to DOD. Specific tasks often include:

- Studies, analyses and assessments
- Laboratory basic and applied research
- Human performance and man-machine interface measurement and evaluation
- Test and evaluation of materials, components and systems
- Support of conferences, symposia and workshops, and technical consulting.

Contracts are awarded for a maximum of 60 working days over a maximum period of 12 months. The daily rate for HSSMFP participants is $175 per day. Commuting expenses, travel, and per diem are not reimbursable.

A final report is the end product of the effort.

❑ **Program Goals and Objectives**

- To advance government scientific and engineering research, and provide 7th to 12th grade teachers with a hands-on experience in a government laboratory.

❑ **Program Promotion Methods and Responsibility:**

HSSMFP is promoted through the Army Research Office web site, the Army's AEOP web site, and word of mouth. All projects must be initiated by the government sponsor.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics: None available.

❑ **Strengths and Challenges**

This is a very small program, which appears to operate well under the radar screen for most of the AEOP program managers and volunteers we interviewed. Currently, this seems to be a vehicle for funding one-of-a-kind projects of interest to an individual researcher and teacher, rather than a strategic tool for promoting Army education and outreach.

❑ **Program Recommendation**

Eliminate Program From AEOP Portfolio or Restructure to Link Directly to AEOP-Branded Programs. The goal of providing high school math and science teachers with hands-on research experiences in Army laboratories is admirable, and clearly, creating these linkages should familiarize the teachers with Army research, military science career opportunities, and the array of programs the Army offers to high school and college students. However, the program is not currently being managed with those goals in mind.

HSSMFP provides a fast and simple contracting process to allow researchers to sponsor teachers, and it would be very beneficial to offer these research experiences to teachers supporting AEOP programs, such as GEMS, MWM and SEAP. Those programs rely heavily on engaged teachers for success, and offering teachers participating in those programs the opportunity for meaningful laboratory experiences as part of that collaboration would be highly beneficial.

However, because Army researchers pay for the teachers they sponsor from their own project budgets (plus a 6% processing fee to ARO), additional funding would be required to accomplish this goal. Given that AEOP programs are already run on a shoestring, creating research experiences for teachers who support AEOP cannot be a top priority at this time. Should adequate resources become available, the Army should use the HSSMFP authority to create meaningful research opportunities for teachers who support AEOP-branded programs.

Appendix III: National STEM Education Programs

Professional Associations

- ***Society of American Military Engineers*** - www.same.org

Alexandria, VA

Purpose: To be a premier global engineering organization leading the professional and personal growth of all members in support of military readiness and development of solutions to national security challenges."

STEM Education: Education and mentoring fund to promote educational, professional development, and mentoring goals; maintains student chapters and a student council; local posts mentor and build relationships between SAME members and students majoring in engineering; annual awards to recognize student leaders; operates three summer camps (CO, CA, MS); supports national Mathcounts competition; supports several scholarships; and promotes engineering career awareness.

Association for Women in Science - www.awis.org

Washington, DC

Purpose: Promote equity and full participation for women in science, mathematics, engineering and technology.

STEM Education: Scholarship program. AWIS chapters and individual members involved in one-on-one mentoring, school lectures, career days, school visits, and teacher workshops.

- ***National Society of Black Engineers*** - www.nsbe.org

Alexandria, VA

*Charneta Samms from ARL is on the National Executive Board

Purpose: Its mission is to increase the number of Black engineers, through developing student interest in engineering, increasing the number of minority students in undergraduate and graduate-level engineering, and providing career advice. Maintains 270 chapters on college and university campuses, and 75 pre-college chapters.

STEM Education: Pre-college initiative involves tutoring and SAT/ACT prep, tours of college campuses and engineering corporations, scholarships, science and engineering projects, and involvement in FIRST Robotics and Mathcounts. NSBE Jr. members participate in seminars and workshops, get free materials on college admission and engineering careers, and are offered competitions on scientific design, oratory, and essay. NSBE offers several scholarships. Has active partnerships with about a dozen organizations.

Some of NSBE's present activities include: tutorial programs, group study sessions, high school/junior high outreach programs, technical seminars and workshops, a national communications network (NSBENET), two national magazines (NSBE Magazine and the NSBE

Bridge), a professional newsletter (The Career Engineer), resume books, career fairs, awards, banquets, and an annual national convention.

American Society of Mechanical Engineers –www.asme.org
New York, NY; Washington, DC Center (202-785-3756)

120,000-member professional organization focused on technical, educational, and research issues.
Purpose: Promote and enhance the technical competency and professional well being of members, and through quality programs and activities in mechanical engineering, better enable its practitioners to contribute to the well being of humankind. Promotes the benefits of engineering education.

STEM Education: Education efforts include workshops, teaching materials and partnership opportunities to help teachers and engineers strengthen the math, science, engineering, and technology skills of young people, as well as to assist them in becoming more aware of the role of engineering in their lives.
Works with universities to develop pre-college engineering education plans, offers on-line lesson plans and activities for classroom use, provides career information, and encourages ASME sections to present workshops for middle school STEM teachers. Has a partnership with the Boy Scouts of American to promote technological literacy, and a partnership with the Girl Scouts to promote STEM and STEM careers to girls. Involved with several contests and competitions.

- ***Minority Scientists Network -***
  http://sciencecareers.sciencemag.org/career_development/miscinet

Washington, DC

Purpose: Sponsored by the American Association for the Advancement of Science; provides a range of resources for minority scientists.

STEM Education: For students, information on science education, persisting in science studies, and career information and counseling is available. The network also provides advice for mentors, and best practices and other information for administrators. Sponsors a jobs bank. Provides news and profiles of minority scientists.

American Indian Science and Engineering Society - www.aises.org
Albuquerque, NM

Purpose: AISES is focused on increasing the representation of American Indian and Alaskan Natives in engineering, science, and other related technology disciplines.

STEM Education: At the K-12 level, sponsors: the National American Indian Science and Engineer Fair, which awards cash prizes and scholarships, as well as some teacher development. K-12 affiliated chapter programs are open to schools with American Indian students and offer opportunities for outreach programs, workshops, and summer programs. Holds national

conference annually, and regional conferences. Has 160 college chapters nationwide. At the post-secondary level, AISES administers five scholarships and a 10-week summer internship program that places students in Federal agencies. No DOD agency participates in the internship program. This year, sponsored 8-10 week internships at universities to increase American Indian students pursuing post-secondary/graduate-level education and careers in computing disciplines.

Society of Professional Hispanic Engineers - www.shpe.org
Los Angeles, CA

Purpose: Founded to provide role models for the Hispanic community. Works to enhance and achieve the potential of Hispanics in engineering, math, and science.

STEM Education: Has 179 student chapters in the United States and Puerto Rico. Pre-college programs include: high-school chapters that provide scholarships, mentors and tutors; assistance with national and local science and engineering competitions, and summer camps; a pre-college symposium on education and careers in science and engineering; and Spanish language engineering comic books. At the undergraduate level, the organization has partnered with NASA and the Department of Energy on internships. For high-achieving students, the organization arranges tours to corporate, university, and government research facilities. Provides a scholarship award to graduate students and a seminar program on graduate student issues. Sponsors national and research conferences and career expos.

- ***Society of Mexican American Engineers and Scientists*** - www.maes-natl.org

Webster, TX

Purpose: To promote excellence in STEM while cultivating the value of cultural diversity by: motivating and mentoring students and professionals; assisting students in securing financial aid and employment opportunities; empowering students, parents, and professionals through educational MAES outreach programs; and stimulating successful partnerships with the community, government, and industry to provide tomorrow's leaders.

STEM Education: Has chapters at about three dozen colleges, clubs at five high schools, and 18 professional chapters. Sponsors a national conference and international symposium annually. Operates four programs: a graduate student network, which provides research opportunities, mentoring, opportunities for networking, and professional support; a K-12 outreach program involving MAES member role models and mentors; the "Science Extravaganza," a one-day hands-on academic enrichment workshops for middle and high-school students; and a scholarship program. Has a formal partnership with NIH.

- ***American Chemical Society*** - www.acs.org

Washington, DC

Purpose: Provides broad range of opportunities for peer interaction and career development. Membership organization of 158,000 members at all degree levels and in all fields of chemistry.

STEM Education: ACS provides programs to engage elementary, middle school, high school, college, and graduate students in chemistry experiences and mentoring. Competitions, summer work experiences, information directories, career education materials, and student clubs (both virtual and school-based) are designed to support students in their studies and assist them in making informed career choices.

Provides teacher resources such as activities guides, teacher training, and learning resources; sponsors a dedicated web site for kids (www.chemistry.org/kids); a operates a community-based science program—Kids & Chemistry—implemented locally by ACS members and local sections. An on-line Virtual Chemistry Club offers: information on chemistry in everyday objects and products, chemical mystery projects, career information, tips for science fair projects, ask-a-chemist, chemistry history, and chemistry experiments.

Offers extensive information on chemical careers geared to high-school aged students. ***ACS's project SEED is designed to encourage economically disadvantaged high school students to pursue careers in the chemical sciences. During the summer, students work in industrial, academic and Federal research laboratories doing hands-on research guided by a scientist-mentor.*** College scholarships are available for SEED students. At the undergraduate level, ACS sponsors: a student exchange; college scholarships for students underrepresented in science fields; and a wide range of support for students such as mentoring, networking, and information on co-ops, internships, and summer jobs.

Educators Organizations

❑ **K-12**

- ***National Science Teachers Association*** - www.nsta.org

Arlington, VA

Purpose: 55,000 members include science teachers, science supervisors, administrators, scientists, and business and industry representatives. Also, serves as the voice for excellence and innovation in science teaching and learning, curriculum and instruction, and assessment. Promotes interest and support for science education.

STEM Education: 18 district organizations.
Has three major initiative underway: Building a Presence for Science, focused on promoting high quality science-based teaching and learning, including a national electronic network for teachers; *SciLinks*, an effort to develop Internet links for science textbooks; and the NSTA Institute, an online professional development program for science teachers. Maintains Internet-based discussion board. Sponsors both national and regional conferences focused on science content, teaching strategy, and research; these include an "Exhibition of Science Education Materials." Administers several awards for teachers and students.

Publishes four magazines for K-12 and college science teachers (Science and Children, Science Scope, Science Teacher, College Science Teaching), as well as numerous science books, and

teaching and assessment guides. Recommends science educational materials, and provides some teacher science resources, including lesson plans.

Plays role in advising NASA on its education efforts. In addition to NASA, partners with numerous corporations and Federal science-oriented departments and agencies (NIST, DOC, NOAA, NSF, USDA, DoEd, Interior, DOT, EPA, and FDA), but not the Department of Defense or any service branch or agency.

- ***National Council of Teachers of Mathematics*** - www.nctm.org

Reston, VA

Purpose: Public voice of mathematics education, providing vision, leadership, and professional development to ensure high quality mathematics teaching and learning. This includes providing guidance and resources for mathematics curricula, serving as a political and public advocate, and bringing existing research into the classroom.

STEM Education: World's largest mathematics education organization, with 100,000 members and 250 affiliates in the United States and Canada. Has program of grants and awards. Sponsors annual national and regional conferences, which include exhibitions. Publishes five journals for mathematics teachers, as well as numerous books. Offers some teacher resources, lesson plans, and student activities.

❑ **Post-secondary**

- ***American Society for Engineering Education*** - www.asee.org

Washington, DC

Purpose: Further education in engineering and engineering technology by: promoting excellence in instruction, research, public service, and practice; exercising worldwide leadership; and fostering the technological education of society. 12,000 members include deans, department heads, faculty, and students, including 400 engineering and engineering technology colleges and affiliates.

STEM Education: Policy positions support: ethics education for engineers, equal opportunity and access to STEM learning/facilities for underrepresented groups, and teaching sustainable engineering. Sponsors annual conference, global colloquium on engineering education, annual workshop on K-12 engineering education, and meetings for 16 geographic sections and zones. Operates an Engineering K-12 Center (www.engineeringk12.org) to gather in one place the most effective engineering education resources available to the K-12 community. This includes: "Go-Engineering," a free e-newsletter sent to thousands of K-12 teachers to help them make math and science studies more exciting; career information; links to lesson plans; data base of K-12 outreach programs (mostly universities); initiative to identify best practices in science and math outreach programs; links to internship programs.

- ***MESA Engineering Program***

(individual programs at schools)

Purpose: The MESA program nurtures minority students for careers in math and science. MESA is carried out at the university-level and seeks to increase enrollment, retention, and scholarships for educationally disadvantaged students.

STEM Education: Originally developed as a partnership between an Oakland high school and UC Berkeley's School of Engineering, MESA has grown to over dozens of programs in 15 states. Some MESA programs have a presence in high schools and middle schools, community colleges, and Indian reservations. Program components may include: study center; academic, career, and financial aid advising; orientation courses; organized group study; fields trips; career development; summer enrichment programs; mentoring and tutoring; and help identifying summer work and part-time jobs.

Networks and Research Organizations

- ***American Association for the Advancement of Science*** www.aaas.org

Washington, DC.

Purpose: An international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association. This includes fostering education in science and technology for everyone, enhancing the science and technology workforce, and increasing public understanding of science and technology.

STEM Education: Takes positions on a wide range of STEM-related policy issues. Operates fellowship program; partners in numerous programs with schools, teachers and librarians; partners with higher education institutions; involved in several projects to increase the participation of groups underrepresented in the STEM workforce; and sponsors a project to advance STEM literacy. Also offers a range of educational materials that educators, parents, and others can use to improve STEM education. Has some focus on career development. Also, one of four sponsors of an NSF-funded Center for Curriculum Materials in Science to develop guidelines for methods and materials to teach STEM.

- ***National Alliance of State Science and Mathematics Coalitions***

Arlington, VA
www.nassmc.org

Purpose: Umbrella organization for state coalitions of business, education and public policy leaders united for the improvement of mathematics, science, and technology education for all students. NASSMC is a network of 37 state coalitions and serves as the national advocate for the member organizations.

STEM Education: Focused on supporting math and science education reform. Publishes briefings on important STEM education issues and sponsors national and state-level conferences. Partners with NASA, NSF, NSA, and the Department of Education, but no DOD organizations.

National Action Council for Minorities in Engineering
White Plains, NY
www.nacme.org

Purpose: Increase the representation of successful African American, American Indian, and Latino men and women in engineering and technology, math, and science-based careers. The NACME forms partnership with corporations, educational institutions, foundations and governmental bodies. NACME and its partners foster research-based changes in policies and practices that ensure equal opportunities for the preparation and participation of all Americans in science, engineering and technology.

STEM Education: Nation's largest private source of scholarships for minority women and men in engineering. Over 15 percent of all minority engineering graduates have received NACME scholarship support. Serves as a conduit for internships. Working to establish a pre-college program. Offers block grants of up to $100,000K to its 44 partner institutions to expand their minority engineering student populations. Offers interactive "Road-map to Engineering" web site.

Junior Engineering Technical Society (JETS)
Alexandria, VA
www.jets.org

Purpose: Increase awareness of and interest in engineering and technology-based careers.

STEM Education: Develops, collects, and disseminates information to schools and students on the opportunities and contributions of engineering and technology professionals. Offers hands-on engineering aptitude self-assessment and technical education for pre-college students. Currently, a partner in UNITE. Sponsors a JETS Teams Competition (14,000 high schools students) hosted by more than 100 universities; and a high-school level engineering design challenge focused on helping the disabled enter or advance in the workplace. Offers nearly 50 JETS challenges for students to solve for a monthly prize. Publishes JETS Pre-Engineering Times e-newsletter. Offers career information.

- ***National Geographic Society***

Washington, DC
www.nationalgeographic.com

Purpose: Promotes geographic knowledge and knowledge of Earth's natural resources.

STEM Education: Offers a wide array of STEM-related educational materials in numerous formats—web sites, magazines, books, pod-casts, photographs, music, television, and films. Publishes five magazines, two focused on youth. Maintains education and children's programming department, and school publishing division. Offers extensive resources and activities for kids, including extensive resources for completing homework assignments. For teachers, offers standards-based lessons plans, other resources and guides, professional

development, and online learning communities. A foundation offers grants to teachers, education institutions, and nonprofits. Sponsors EdNet, an online service offering news, information on professional development opportunities, on-line communities, e-newsletter, and information on grants.

American Society of Civil Engineers- Reston, VA- www.asce.org

Purpose: Leadership, advancing technology, and advocating lifelong learning and promoting the civil engineering profession.

STEM Education: Focuses on a large number of engineering fields of interest to the Army. Provides fun engineering activities, and education and career information for kids. Sponsors two competitions, one on future cities and one on bridge design. Offers K-12 teacher resources, including a summer institute program. Also sponsors a teaching workshop for college faculty. Offers extensive career guidance and information. Represents more than 137,000 members.

Girl Scouts of America: Girl GoTech *(New York, NY)* - www.girlsgotech.org

Purpose: Helps girls around the country learn more about math, science and technology with opportunities such as science camps, science kits, and hands-on activities.
STEM Education: Web-resource for promoting math, science, and technology and STEM careers to girls.

Appendix I: Framework of Analysis

GOALS

AEOP Portfolio:

- Increase the interest and awareness of students from all backgrounds in STEM fields;
- Develop high-potential U.S. talent for careers in science and technology;
- Attract a fair share of available talent to the Army S&T community.

Individual AEOP Programs:

Recommended goals for each of the individual AEOP programs are included in the program review section of the report.

PROGRAM CATEGORIES

RESEARCH OPPORTUNITIES

Inclusive Introductory Research Opportunities (Grades 8-12):

- Materials World Modules (MWM)
- Gains in the Education of Math and Science (GEMS)
- Army High Performance Computing Research Center (AHPCRC) Internships
- Internship Science and Engineering Program (ISEP) (CERL)
- Uninitiates' Introduction to Engineering (UNITE)
- Research and Engineering Apprentice Program (REAP)

Advanced Research Opportunities for High-Potential Students (Grade 11-Higher Ed):

- Science and Engineering Apprentice Program (SEAP)
- College Qualified Leaders (CQL)
- Consortium of Universities of the Washington Metropolitan Area (CUWMA)
- Career-related Experience in Science and Technology (CREST)
- Women in Science Program (WISP)
- AHPCRC Internships
- Student Career Experience Program/Student Temporary Employment Program
- Army Intern Program
- Summer Research Opportunities Program (SROP) (CERL)

COMPETITIONS

Inclusive Introductory Experiences (Grades 6-9):

- eCYBERMISSION
- Local Science Fairs and Competitions

Advanced Experiences for High-Potential Students (High School):

- Junior Science and Humanities Symposia (JSHS)
- Intel International Science and Engineering Fair (ISEF)

- International Mathematics Olympiad (IMO)

KEY PROGRAM COMPONENTS IN EACH CATEGORY

RESEARCH OPPORTUNITIES

Inclusive Introductory Research Opportunities (8-12):

- Fun, hands-on research experiences, becoming deeper and progressively more challenging as students move through each year of high school
- Demonstrating link between science and technology and every day life
- Interaction with and exposure to Army scientist and engineer role models
- Individual and group mentoring
- Encouragement to pursue advanced math and science in high school
- Encouragement to attend college
- Age-appropriate career information for students, parents and teachers

Advanced Research Opportunities for High-Potential Students (11-Higher Ed):

- Early identification of promising candidates
- Direct mentoring by Army scientists and engineers
- Continuing opportunities for work/study, internships and summer jobs with Army laboratories or those supported by the Army throughout the candidate's education
- Providing information specific to career opportunities with the Army or its contractors
- Encouraging candidates to undertake Army or military-relevant research at the graduate level
- A focus on non-technical skills needed for career success
- Aggressive recruitment at degree completion

COMPETITIONS

Inclusive Introductory Experiences (Grades 6-9):

- Focus on interest-building and awareness
- Fun, hands-on math and science learning activities
- Demonstrating link between science and technology and every day life
- Emphasis on teamwork and collaboration
- Strong support for students from participating schools and teachers
- Interaction with and exposure to Army scientist and engineer role models
- Age-appropriate career information for students, parents and teachers

Advanced Experiences for High-Potential Students (High School):

- Opportunities for in-depth research and experimentation in science, engineering and mathematics
- Emphasis on real-world, science and engineering-based problem solving
- Strong support from participating teachers and schools
- Adequate technical support and mentoring throughout the project
- Interaction with and exposure to Army scientist and engineer role models
- Age-appropriate career information for students, parents and teachers
- Identification of promising candidates
- Recruitment into Army-supported advanced research experiences

METRICS

Overall AEOP Portfolio:

- Number of AEOP students pursuing advanced math and science in high school
- Number of AEOP students who return to AEOP programs each year or progress from one AEOP program to another
- Student attitudes toward math and science based on pre and post-tests
- Level of interest in military science careers, based on pre and post-tests
- Number of AEOP students who enter college
- Number of AEOP students who select science and engineering majors in college
- Number of AEOP students who complete undergraduate science or engineering degrees
- Number of AEOP students who become Army employees, or pursue military science careers
- Number of AEOP students who enter public service

Individual AEOP Programs:

Recommended goals for each of the individual AEOP programs are included in the program review section of the report.

Appendix II: Analysis of Individual AEOP Programs

Grades 6-9

ECYBERMISSION

High School

GEMS

IMO

ISEF

JSHS

REAP

UNITE

High School/Higher Education

AHPCRC

CUWMA

CREST

SEAP/CQL

STARS

WISP

Teachers

MWM

FREP

HSSMFP

eCYBERMISSION

❑ Program Overview

Date established: 2002

Lead Army Organization: Army Research Laboratory

Management Structure: Oversight by a full-time Army employee, with full administrative and program management support outsourced to Booz Allen Hamilton.

Participating Organizations/Locations:
ASAALT
Army Research Lab (ARL), Adelphi, MD and Aberdeen Providing Ground, MD
Aviation & Missile Research, Development, & Engineering Center (AMRDEC), Huntsville, AL
Consortium Universities of the Metropolitan Washington Area (CUMWA), Arlington, VA
Space Missile Defense Command
Army Material Command
Medical Research and Material Command
Corps of Engineers

Annual Budget:
2004/05: $4.378M total:
Awards - $2.575M
Administrative - $1.724M

Target student population:
- 6th-9th grade students nationwide, U.S. territories, and DODEA schools.
- eCYBERMISSION seeks a diverse group of participants with a wide range of proficiency levels, interests and backgrounds.

Student selection:
- On-line registration by 3 or 4-person student teams, with team advisor (teacher, other qualified school advisor and/or parent). Formal application must fulfill the requirements and format of the "Mission Folder".
- Winners are selected by qualified volunteer judges reviewing online.

Number of Students Served:
2003/04: 4148
2004/05: 7960 [# teams: 1900 registered; 1151 completed entries]
2005/06[1]: 4035 [# teams: 1,602 teams registered; 1111 completed entries]
(Army program manager and contractor suggested that the decline in 2005/06: from states w/ high number troop deployments)

Number of Participating Teachers:
2003/04:512
2004/05: 517

Administrative Cost per student:
2003/04: $550
2004/05: $216

[1] 2005/06 data from contractor's press release

Growth Trajectory: The substantial commitment of resources and high level of engagement by the Army would suggest more rapid growth in eCybermission than is the case. In reality, the twin challenges of engaging teachers' attention and time and of finding sufficient numbers of Army volunteers have been and will continue to constrain rapid growth. To the degree that the program becomes well-recognized nationally and on the state level, that recognition may serve to drive local interest from schools and school districts.

❑ **Brief Program Description:**

eCybermission is a web-based science, math, and technology competition that fosters collaborative learning through a team format, on-site discussion forums, and access to an array of resources, including online "eCyber mentors". Students work in teams of 3-4 students in the same grade, mentored by an adult supervisor (usually a teacher) to identify and solve challenges in their communities. By applying science to a problem affecting the community, students not only discover the applications and relevance of science, math and technology but also realize how they can make a difference in their communities.

Students compete in one of 4 regions, with 2 overall awards per region, per grade, including $3,000 savings bonds for each, and travel costs to National Judging and Educational Event for the 1st place winners. In addition, each region makes 4 Criteria Awards per grade of $2,000 savings bonds per student winner.

The 1st place regional finalists compete in Washington, D.C. for the National Awards, with a 1st place winning team in each grade. These students receive a $5,000 savings Bond, medal and plaque. The other National Finalists (3 per grade) receive $3,500 savings bonds and medal.

Army volunteers serve as Ambassadors (promote program through outreach to schools and teachers); Guides (online mentors and resource for students); and installation POCs. Judges (who may be either DOD employees or from private sector) review each application according to established criteria.

❑ **Program Goals and Objectives**

- Established in response to a call by General Shinseki for a "Science Fair for the Nation", to address the national decline in science and math scores among students by:
  - ♦ Increasing interest in science, math and technology among middle and high school students.
  - ♦ Raising the visibility of the Army as leaders in science, math and technology.
  - ♦ Being a premier and inclusive forum for learning.
  - ♦ Broadening participation beyond conventional science competitions.
  - ♦ Leveraging human resources to ensure a successful outcome.
  - ♦ Ensuring basic competition framework that can be sustained over time.
  - ♦ Meeting the increasing math and science staffing demands of a global market.
- eCYBERMISSION fosters collaborative learning through onsite discussion forums and access to an array of resources.
- eCYBERMISSION promotes the importance of real life applications of science, math and technology through several "themed Mission Challenges" to solve problems in their community.

❑ **Program Promotion Methods and Responsibility:**

The contractor, Booz, Allen Hamilton provides extensive materials, training and support for Ambassadors and

Installation POCs and for CyberGuides, including a Welcome KIT with turnkey program materials for each volunteer responsibility. The contractor also promotes the program to external and internal audiences via:
press releases/media advisories and articles to Army, educational and general media; media coverage of road-show events and the National Judging and Educational Event; promotional and print materials to reinforce brand; targeted web and print advertising.

Installations/Commands: Volunteer Ambassadors initiate connection/engagement to schools via: local dissemination/communication with school district offices, principals, teachers, parents; direct marketing/mailing to teachers; attendance at educational conferences; direct outreach to individual schools, school districts.

AEOP provides passive promotion via the eCybermission website and the AEOP website.

- **Data/Outcomes/Other metrics:**

Formal or informal evaluation:

The contractor develops annual report derived from online attitude surveys of Army volunteers, and website "suggestion box" for students, teachers/advisors.

Current program metrics:

- Growth in student participation.
  During the 2005 competition year, there was at least one team from each state and territory.
- One of the challenges in developing satisfaction and impact metrics has been the limitation on collecting and tracking student data. The contractor offers an online "suggestion box" on the internal eCybermission website for teachers and students, but the response rate in 2005/06 was minimal – just 4% of students and 9% of teachers.

Qualitative metrics:

- Anecdotal information from contractor indicates that a relatively high number of teachers have returned as advisors for a 2nd year, which would indicate they found value for their students in the experience.
- Anecdotal information also suggests that parents of the winning students also are very engaged, and very excited at the opportunities their children are getting through eCYBERMISSION.

- **Strengths and Challenges**

eCYBERMISSION's great strength is its ability to connect students to the role science plays in meeting real-world challenges in their communities and to do so in the web-based, interactive format that aligns with the habits and expectations of today's students.
It offers the challenge and opportunity to the students in developing abilities and experience in creative research, scientific inquiry, and collaborative learning.

Content:
The choice of one of four "themes" demands that students focus on pressing issues and the need for the team itself to choose a topic requires research and evaluation by the group. The team-based format requires collaborative learning and the use of web-based resources. The content is said to correlate with science standards for middle school, but this information is not available on public website and the contractor was reluctant to offer "fake" registration).

The outcomes are clearly defined and stated, and the judges use the questions in the student team applications as the template for judging. The content is challenging, as is the process of developing an application. The application's emphases are on scientific thinking and processes.

Engagement, Personalization and Commitment:
The program is structured to provide students with access to mentors and experts, but the limited or no data that the program is allowed to collect makes it difficult to gauge the actual success of this option. First and foremost, there is

no data or information available about the interactions between teams and their teacher/advisors. Second, there is no data and only anecdotal information available about the type and value of online interactions between students and the Cyberguides. It also is not clear whether students like and/or use Cyberguides and/or the eCybermission website chat and schedule "seminar" features.

Further, while Cyberguides are meant to be available to students during the day and evening, in 2004/05, only 18 Army volunteer Cyberguides were available and in 2005/06, only 59 – for an estimated need of 75 in each year. Low volunteer response in 2005/06 suggests either or both: lack of awareness of program, lack of local leadership support, lack of volunteer interest or overly demanding time commitment. There also have been suggestions that the wartime footing of the Army limits the availability of volunteers.

A significant barrier to rapid expansion and ultimate success of the program as a "science fair for the nation" is the dependence on Army volunteer "Ambassadors" to contact teachers and schools (often with little knowledge of either); and on skilled teachers who have the capacity to motivate/advise team projects and who are willing and able to commit the necessary time to the project. Successful outreach to the schools and teachers depends on relationship building over time and on word of mouth among teachers; yet Army volunteers often change yearly.

Dosage/Duration: While the final competition and awards ceremony is well attended by top Army leadership and is highly branded, the success in branding it on the local level is far from the case, not only in terms of public awareness but in terms of Army buy in.

❑ Program Recommendations

Expand national promotion and awareness.
Responses to BEST interviews suggest that neither Army labs nor school principals and teachers are aware of or understand the "value proposition" of eCYBERMISSION. This is a particularly significant hurdle because of the time commitment for volunteers and for teachers. It is also the case that the relatively new eCYBERMISSION program must compete for time with local and/or well-established K-12 science programs. Teachers view it as add-on project; although it is set up to integrate with science standards, this information is not available until after a teacher registers.

Develop opportunities (possibly via the website or eCyberguides), for communication with all eCybermission students in order to:
- Provide feedback to non-winning students and their teacher-advisors;
- Inform students about Army and other program opportunities;
- Add opportunities to connect non-winning but interested eCYBERMISSION students to introductory lab experiences to the extent possible, given geographic and capacity limitations.

Add additional information to the Army volunteer "welcome" kit and to the website:
- Information about the structure and operation of schools and school districts;
- Information that defines eCybermission's "value proposition" from perspective of schools
- Improve accessibility to all of the website's information, instead of providing much of the information only after a teacher has registered.

Benchmark eCybermission against the Internet Science and Technology Fair. This is a longer-established program, with similar attributes and goals to eCYBERMISSION. http://istf.ucf.edu/

❑ Recommended Goals

Create national brand for eCybermission

Streamline volunteer requirements across Ambassadors and Cyberguides.

- **Recommended Metrics**

  - Student attitudes toward eCYBERMISSION experience, based on online pre and post-tests.
  - Student attitudes toward science and math based on pre and post-tests.
  - Increase in student awareness of the role science plays in solving real-world challenges.
  - Number of students returning to the eCYBERMISSION program for multiple years.
  - Number of students moving from eCYBERMISSION into other science interest and awareness activities.
  - Participating schools re: number of years participating; location; number of teachers/teams in school.

The Intel International Science and Engineering Fair (ISEF)

❑ Program Overview

Date established: Founded by Science Service (nonprofit organization in 1950, with Intel as sponsor. Army participation began 1960s

Lead Army Organization: ARO/Youth Science Programs

Management Structure: Oversight by Army personnel.

Participating Organizations/Locations: There are about 475 science fairs; the Army participates in ~325.

Annual Budget: There is a fee per judge for participation. No information available on the amount or on number of Army judges.

Target student population: 9^{th}-12^{th} grade students.

Student selection: Each student must first compete in an "affiliated fair" that must consist of five participating high schools or 50 students in the 9th-12th grades. Each affiliated fair can then send two individual project finalists and one team project to compete in the Intel ISEF.

Number of Students Served: in 2006, the Army presented 20+ awards on the state and regional levels.

Cost Per Student: N/A

❑ Brief Program Description:

The Intel International Science and Engineering Fair (Intel ISEF) is the world's largest pre-college celebration of science. Held annually in May, the Intel ISEF brings together nearly 1,500 students from more than 40 nations to compete for scholarships, tuition grants, internships, scientific field trips and the grand prize: a $50,000 college scholarship.

Science Service, a non-profit organization based in Washington, DC, founded the ISEF in 1950 and is very proud to have Intel as the title sponsor of this prestigious, international competition. Science Service's mission is to advance public understanding and appreciation of science among people of all ages through publications and educational programs. Science Service has encouraged students, parents, teachers, and communities to explore the vast world of science.

The Army participates by providing judges on to science fairs in various locations. The Army assists in identifying judges (must have PhD. or equivalent experience in particular subject area) within particular location and pays a fee to participate in the affiliated fair; and in providing awards.

Awards are presented by organizations and government, the latter including the Army, Navy, Air Force, Coast Guard, Department of Homeland Security, etc. Each organization determines its own awards; in 2006, the Army presented 15 awards on the state level of three $1,000 U.S. Savings Bonds, a certificate of achievement and a gold medallion, and regional awards of certificates, bronze medallion and T-shirt. Two students per region go to international level, receiving either:

Winners receive an all expense paid trip to Operation Cherry Blossom in Tokyo, Japan. Each trip winner will also receive three $1,000 U.S. Savings Bonds, $300 from the Association of the United States Army, a gold medallion and a certificate of achievement. In addition, One all expense paid trip to London International Youth Science Forum, three $1,000 U.S. Savings Bonds, $300 from the Association of the United States Army, a gold medallion and certificate of achievement.

❑ Program Goals and Objectives

The Intel ISEF provides an opportunity for the best young scientists from around the globe to share ideas, showcase cutting-edge science projects, and compete for over $3 million in awards and scholarships.

- **Program Promotion Methods and Responsibility:**

Volunteer judges are solicited by ARO program manager and/or from Army leadership of individual labs and installations.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None from Army

Current program metrics: None from Army

- **Strengths and Weaknesses of Program**

Comments from interviews with individuals who have served as judges for multiple years:

- Gives kids remarkable opportunity to see range here and also in other countries (UK, Japan).
- Provides good exposure to students of another side of Army (as opposed to "Army at war").
- It is not feasible or relevant to track ROI for the Army because the "payoff" comes far down the road; although one effect may be that students don't automatically eliminate Army as career.
- Number of judges is growing smaller b/c of funding limitations, while the number of students is increasing (i.e. last year there were 2 chemistry judges for 70 chemistry projects)

- **Program Recommendations:**

- Ensure that information on ISEF is included in general AEOP announcements about programs.

- **Recommended Metrics: N/A**

JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM (JSHS)

❑ Program Overview

Date established: 1968 by ARO; 1996 joined by Navy and Air Force

Lead Army Organization: ARO/Youth Science Programs

Management Structure: Program oversight by Army personnel; Academy of Applied Sciences provides management and promotion.

Participating Organizations/Locations: 47 colleges and universities

Participating Army Organizations in JSHS Regional program:
ARO
ARL
Armed Forces Communications-Electronics Association
Association of the United States Army
Society of American Military Engineers
Army Corps of Engineers,
Communications-Electronics Command
Military personnel stationed in Europe and the Pacific
US Army Tank-Automotive Research
Development and Engineering Center
ROTC Units at multiple campuses

Participating Army Organizations in National program:
ARO
ARL
Various host Army Organizations and staff

Annual Budget[2]:

Total Funding: FY04 - $1.0M; FY03 - $1.05M

- *Regional program:* Cost of symposia ($802,000); scholarships ($216,000); teacher awards ($24,000 awarded to teachers)
  [Some regions leverage funds and fund more, for example: Missouri had ~500; upstate NY ~ 600]
- *National program:* $296,500

Scholarships: $144,000 (18 students); support for London trip ($21,000); participant cost ($988)

Administrative cost is shared between services and universities; since universities receive no funding, viewed as "volunteers"

Target student population:
Grades 9-12; students who are U.S. citizens and permanent residents from all states and DOD schools; some outreach to schools with underrepresented populations capable of succeeding in the programs.

Student selection:

- Schools nominate candidates from program;

[2] All 3 services provide direct funding/student for food and lodging (used to do travel but not much anymore b/c too expensive); doesn't cover cost of teachers

- Universities administer regional symposia and invite participation of high school students who have completed a research investigation in science, engineering or math. These students vie for awards and the opportunity to advance to the National Symposium.
- Students submit a written report (e.g. abstract and/or paper) of the original research investigation for review by a regional panel of judges
- Students deliver a concise oral presentation to the symposium

Number of Students Served:

Regional program: approximately 9800

National program (FY05): 240 student delegates; 48 students competing for military-sponsored scholarships.

Number of Teachers Involved (2005 National program): 96

Number of Adult Leaders (2005 National Program): 160

Cost per student:

- *Regional program (annual average):* Cost per student per day ranges from $10 to $90 (includes military funding only)
- *Regional program:* Regionals + scholarships + teacher awards divided by number of students and teachers participating = $106 per head
-

Growth Trajectory: Increases in costs of travel, lodging and other expenses have increased necessary cost per student and cut into ability to expand numbers of participants.

❑ **Brief Program Description:**

The Junior Science and Humanities Symposia (JSHS) Program promotes original research and experimentation in the sciences, engineering, and mathematics at the high school level, and publicly recognizes students for outstanding achievement.
The annual competition is designed to encourage and develop oral presentation skills and the ethical conduct of original research.

JSHS regional symposia, hosted and overseen by designated universities, invite high school students who have completed an original research investigation in the sciences, engineering, or mathematics to apply to the regional symposium and vie for awards, including the opportunity to advance to the National symposium.

The Regional Symposium winner and four additional students in each region are provided an all expense paid trip to attend the National Symposium. Awards at the National include: eight $16,000 undergraduate tuition scholarships (each 1st place finalists); eight $6,000 undergraduate, tuition scholarships (each 2nd place runner-up finalist); eight $2,000 undergraduate tuition scholarships to each 3rd place runner-up finalists. In addition, each first place finalist is awarded an expense-paid trip to the London International Youth Science Forum.

❑ **Program Goals and Objectives**

- Widen the pool of trained talent prepared to conduct research and development vital to our nation, by connecting talented students, their teachers, and research professionals at affiliated symposia and by rewarding research excellence.
- Support and encourage the success of high school teachers in addressing the attainment and mastery of state and national performance and process skills standards in the sciences, mathematics, and languages arts by their students.
- Promote research and experimentation in the sciences, engineering and mathematics at the high school level
- Recognize the significance of research in human affairs and the importance of humane and ethical principles
- Expand the horizons of research-oriented students by exposing them to opportunities in government, academia, and industry

❑ **Program Promotion Methods and Responsibility:**

The contractor, Academy of Applied Sciences (AAS), has responsibility for:

- Identifying the host institutions, communicating with interested institutions about JSHS and the work requirements, and maintaining a list of institutions capable of conducting the regional symposia;
- Publishing materials, such as the RFP, brochures, website information, news releases;
- Traveling to regional symposia to monitor and evaluate their success;
- Overseeing the advisory committees at the regional and national symposia level.

The universities that serve as hosts for the regional program are responsible for local/regional promotion, which varies according to the university and other organizations.

The Army's external promotion is primarily via the AEOP and JSHS program website, and individual Army personnel and/or locations who are involved with the program.

❑ **Data/Outcomes/Other Metrics:**

Formal or information evaluation:

Attitude survey of scholarship student delegates and adult leaders (2005: 30% of 240 students responded), that focuses on satisfaction/dissatisfaction with competition, and interest in STEM and plans for college study. The 90% positive response rate in each category suggests that participants in JSHS are already candidates for study/career in STEM fields, and that 89% had participated in other science competitions.

Current program metric:

- Number of undergraduate scholarships awarded:

1996-2003: Army has awarded 311 undergraduate scholarships

- Number of winners who subsequently enrolled in graduate school (via survey)

56 out of 311 scholarship winners were enrolled in graduate school. 3 of the 56 reported plans to pursue a Ph.D. (and one was for MD). Not a good ratio for getting a researcher.

- Number of scholarship recipients who remained connected to government:

50% of the recipients who responded to survey and participated in research beyond high school did so on the government or military dollar; although significantly more students used funding from NSF and NIH.

Each symposium lasts 2-3 days and therefore too limited a timeframe for useful measurement. There currently is no pre-testing/assessment, but this could be established on the regional level.

❑ **Strengths and Challenges**

The Army's participation is primarily at the competition level (regional and national) which provides opportunities for visibility and information for students, but little mentoring. According to the contractor and respondents to 4 surveys sent randomly to a sample of university program managers, the Army local leadership offers little support to JSHS in identifying military personnel for participation in the regional symposia. There is frequently a lack of communication between the military (the 3 services take turns hosting the national competition) and the regional university. This may result in part because attachment to JSHS is occurs at the individual level (judges), rather than to an Army lab.

The armed services added scholarship funding some years ago. From the contractor's perspective, this led to JSHS becoming more competitive, with the characteristics of a contest rather than an opportunity to develop and present research. The four survey respondents noted efforts and success in reaching all ofo the schools in their area; each also described an increase in requests for participation and an increase in recommended students.

The static level of military funding inhibits expansion in numbers of students that can be involved via military dollars. At one point, there was some discussion about putting the symposia on the Internet, in order to reach more students and reduce costs. The regions argued in opposition that face to face interaction and presentations with peers and professionals was too important for students to eliminate. In addition, there is a lot of exposure during the national symposium to military R&D as a career option, so the military remains a strong proponent of maintaining the face to face interaction.

There has been a decline in the number of high schools that participate, apparently because the No Child Left Behind Act has had an effect on student participation in independent research projects. Further, the requirements for NCLB testing has prompted high schools with large socio-economically disadvantaged populations to increase focus on teaching for the test, reducing available teacher and student time for this type of program.

There is some concern about habitual funding of the same universities; although there has been no suggestion that some universities are not fulfilling their responsibilities. There appears to be little across the board assessment of this, however. There also appears to have been no examination of whether there are universities that have become better positioned to host the regional symposium than the one initially chose some decades ago.

❑ Program Recommendations

- Expand outreach to Army labs and contractors that are located in the university regions, in order to establish awareness of JSHS and to encourage opportunities for Army personnel to participate on local JSHS review panels and boards.
- Consider involving the Army Centers of Excellence as participating universities.
- Offer more professional development for teachers during the regional and national symposia.
- Extend REAP's student eligibility to include 9th grade, and promote REAP as opportunity for "next steps" for JSHS participants.
- Explore possibilities for expansion of number of universities in order to provide more or new locations, such as pairing universities for alternate year hosting.

❑ Recommended Goals

Expanded Army awareness of JSHS and potential value of identifying these students for potential internships and career development.

❑ Recommended Metrics

- Standardize the regional assessment instruments, which vary from minimal attitudinal surveys among students and teachers to detailed requests of the university managers about students, success in recruitment, fundraising to support additional students, etc.
- Do longitudinal study of the winners and participants as they progress from undergraduate to graduate school and into STEM careers.

THE INTERNATIONAL MATHEMATICS OLYMPIAD (IMO)

❑ Program Overview

Date established: The IMO began in 1959; the USA has participated since 1974.
US Program under the auspices of the Mathematical Association of America.

Lead Army Organization: ARO/Youth Science Programs

Management Contractor (for entire program): University of Nebraska

Participating Organizations/Locations: SMDC, AMRDEC, ERDC (Vicksburg)

Annual Budget:
The Army provides the necessary funding for the travel of the team to represent the United States at the International Mathematical Olympiad.
IMO held in different country each year.

Target student population:
Open to students 20 years of age and under with no post-secondary school education, who are U. S. citizens and students legally residing in the United States and Canada.

Student selection:
Approximately 250 of the top scoring American Mathematics Competition participants are invited to take the US American Math Olympiad. The twelve top scoring USAMO students are invited to a two day Olympiad Awards Ceremony in Washington, DC sponsored by the MAA, the Akamai Foundation, the Microsoft Corporation and the Matilda Wilson Foundation. Six of these twelve students will comprise the United States team that competes in the "International Mathematical Olympiad (IMO).

Number of Students Served: U.S. team comprised of six students, with two adults.

Cost Per Student: Not Available

❑ Brief Program Description:

The USAMO is part of a worldwide system of national mathematics competitions, a movement in which both educators and research mathematicians are engaged in recognizing and celebrating the imagination and resourcefulness of our youth. The USAMO is a six question, two day, 9 hour essay/proof examination. All problems can be solved with pre-calculus methods.

❑ Program Goals and Objectives

- The USAMO (United States of America Mathematics Olympiad) provides a means of identifying and encouraging the most creative secondary mathematics students in the country. It serves to indicate the talent of those who may become leaders in the mathematical sciences of the next generation.
- The members of the Committee on the American Mathematics Competitions (CAMC) are dedicated to the goal of strengthening the mathematical capabilities of our nation's youth. The CAMC believes that one way to meet this goal is to identify, recognize and reward excellence in mathematics through a series of national contests called the American Mathematics Competitions.

❑ Program Promotion Methods and Responsibility:

There appear to be none that are generated by the Army. The ARO home page includes the choice of "outreach programs" in its lengthy menu; the outreach programs page includes IMO but no reference to Army sponsorship or what it's for. The AEOP website refers visitor to IMO home website, which is hosted by Canada. Clicking on USA

sends the visitor to the Mathematical Association of America competitions home page, which includes 10+ menu tabs. The tab labeled "who's who" lists "Sponsors", which are the Math Association, University of Nebraska, ONR and ARO. There is no other information provided.

- **Data/Outcomes/Other Metrics:**

The US team consistently ranks in top 3 countries of more than 80 represented

Formal or informal evaluation: Success in competition.

Current program metrics: Success in competition and US rank among all nations that participate.

- **Strengths and Challenges**

The IMO is not an Army program but a program that receives some funding from the Army. The strengths and challenges of the IMO system itself are beyond the scope of this analysis.

- **Program Recommendations**

If the Army continues to provide funding, the primary challenge is how to increase Army branding both within the national and international mathematics competition community and also within the Army S&T community.

MATERIALS WORLD MODULES (MWM)

❑ Program Overview

Date established: 1994: Developed by Northwestern University under an NSF grant
2003: Adopted by DOD/Army (championed by former Deputy Under Secretary John Hopps)

Lead Army Organization: Armament Research Development & Engineering Center (ARDEC), Picatinny, New Jersey; DOD Ordnance Technology Consortium

Management Structure: MWM is managed internally by a dedicated half-time contract employee, and supported by another half-time contract employee, both of whom are retired military officers.

Participating Organizations/Locations: 4

RDECOM—ARL, Aberdeen Proving Ground, MD
County College of Morris, Randolph, NJ
Naval Surface Warfare Center—Indianhead, MD and New York—Benet

Annual Budget:

- $200,000 in FY06 from the Army.
- DOD is investing $500,000 in FY2006 to support the Summer Institute at Garrett College, and $2 million to begin scale-up in Maryland in FY06.
- $5 million has been requested in the Administration's FY07 DOD budget to support MWM roll-out in Maryland, and begin a national scale-up.

Target student population:

- Middle and high school students.
- During the pilot phase, geographic locations have been limited to a few school districts proximate to Army laboratories.
- MWM's goal is to launch state-wide in Maryland starting in the fall of 2006, and then expand nationally.

Student selection:

- Teachers elect to use MWM content in their regular classes.
- School districts must sign an Educational Partnership Agreement.

Number of Students Served (2005): 6,600

Number of Participating Teachers: 55-65

Estimated Cost Per Student: $10 per student (each $750 kit contains materials for 75 students). Does not include professional development for teachers, administrative or overhead costs.

Growth Trajectory: DOD plans to roll MWM out statewide in Maryland over a three year period. MWM plans to work through the Maryland Community Colleges, and the resources anticipated from DOD appear adequate to accomplish this plan.

❑ **Brief Program Description:**

The Materials World Modules (MWM) Program has produced a series of interdisciplinary content modules based on topics in materials science, including Composites, Ceramics, Concrete, Biosensors, Biodegradable Materials, Smart Sensors, Polymers, Food Packaging, and Sports Materials. The modules are designed for use in middle and high school science, technology, and math classes. MWM is based on principles of inquiry and design, and emphasizes active, hands-on learning. MWM provides middle and high school students of all ability levels with opportunities to apply what they learn in the classroom to real-world problems, while helping teachers to meet National Science Education Standards.

Developed at Northwestern University in 1994, the MWM Program was established to develop and disseminate supplemental materials education curricula for high school students. Given the pervasiveness of materials in everyday life, the developers of MWM felt that the study of materials would facilitate students' discovery of the interconnections between science, technology, and society.

Each MWM module focuses on a specific type of material. Nine modules have been created thus far, and each module was field tested by high school teachers in a wide array of courses, including chemistry, physics, biology, earth science, physical science, technology and engineering, and mathematics. Teachers in all subject areas reported that the use of the modules enabled students to make connections between concepts from the traditional curriculum and the world around them more frequently than ever before. Teachers also reported gains in content knowledge and design capabilities based on pre and post-tests.

❑ **Program Goals and Objectives**

- Strengthen U.S. talent pool for science, math and engineering.
- Increase the number of U.S. students pursuing careers in science, math and engineering.
- Provide content to enrich school curriculum and spark students' interest in science, math and engineering.
- Maximize resources and value by using leading edge techniques like distance learning.
- Measure and evaluate program performance for improvement opportunities for justification.

❑ **Program Promotion Methods and Responsibility:**

The program is promoted by the Army, DOD and Northwestern University through training teachers, distribution of MWM kits, and participation of volunteers in schools located near DOD research facilities. MWM kits also have been distributed to the science teachers who advised the national winners of the eCYBERMISSION competition. Promotional activities, targeted at pilot sites in New Jersey and Maryland, include participating and exhibiting at national and regional events, maintaining a web site, distributing program brochures, and through word of mouth. MWM also currently uses an informal "ambassadors" program through which Army scientists are recruited to reach out to their local schools and share information about MWM. These ambassadors are encountering resistance from some schools, while other schools are accepting the MWM kits, but not necessarily using them in their classrooms.

Another element in MWM's current dissemination efforts is to provide teacher training on both inquiry-based learning, as well as introduction of the MWM modules. A few teacher training sessions already have been held, most recently, in early July for a group of approximately 20 teachers.

MWM has now adopted an aggressive dissemination strategy to "saturate" the State of Maryland over the next three years, in partnership with Garrett Community College. The first step in the Maryland roll-out will be conducting a formal evaluation of MWM, as described in the evaluation section below. Once that evaluation is complete, and assuming successful results, MWM is poised to work with Garrett to disseminate MWM throughout the State of Maryland by the end of 2008. Maryland was selected because of the significant DOD laboratory and contractor presence, and the resulting availability of volunteers.

Garrett will house a statewide resource Center to help schools and teachers adopt the content. MWM will also work through state accrediting processes to have MWM adopted as supplementary curriculum for middle and high school students. Using DOD funds, Garrett will provide small grants to educational partnerships led by local community colleges to help the community colleges work hands-on with their local schools to train teachers, and provide services needed to introduce MWM curriculum in as many middle and high schools as possible throughout Maryland.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: Because MWM will be delivered in science classrooms in Maryland, MWM has aligned its content with Maryland science standards, and will conduct an evaluation during the summer of 2006 using rigorous evaluation protocols consistent with Department of Education guidelines. 96 students from throughout the State of Maryland will participate in a full-day educational program for four weeks. Half of the students will be taught using MWM, and the other half of the students (the control group) will be taught the same principles of math and science that are embedded in the MWM modules using more traditional methods of direct instruction. Students will be tested weekly to determine their level of achievement, as well as attitudes toward the study of science and interest in science careers.

This study will provide the DOD and the Army with evidence regarding whether or not MWM is effective in improving the achievement of participating students, as well as generating an interest in pursing additional math and science courses.

Current program metrics:

- A log is kept recording kit distribution at pilot sites.
- Pilot sites report informally on the number of teachers who use the MWM modules, and how many students are reached.
- DOD volunteers solicit feedback from teachers at pilot sites.
- Reporting metrics for MWM will be assumed by Garrett College.

- **Strengths and Challenges**

MWM's greatest strength is the development and testing of engaging content. The MWM content was developed under an NSF grant, with both science and engineering faculty and high school teachers participating in development. MWM content is inquiry-based, and inquiry-based approaches have consistently been found more effective than traditional science curricula, as measured by student achievement.[3] Content was tested and refined based on testing with more than 5,000 students and extensive teacher feedback. The MWM content is being evaluated to determine effectiveness in impacting student achievement and attitudes. In addition, the content was developed to meet National Science Education Standards. As a first step to widespread dissemination in Maryland, the MWM content also is being aligned with Maryland standards.

The MWM program faces a number of significant challenges, however. First, because MWM will be delivered in the classroom, it will be subject to all the same pressures as other parts of K-12 education, and the DOD/Army will be working in an area where it has very limited experience. Ultimate success of MWM will depend heavily on the willingness of schools and school districts to sign educational partnership agreements, and the quality and commitment of the teachers who agree to use MWM in their classrooms.

For example, during its pilot phase, MWM modules have been disseminated through an informal ambassador program through which participating Army volunteers work directly with local schools to encourage teachers to adopt MWM content in their classrooms. A number of the volunteers involved in the dissemination reported that many of the teachers who received the kits never used them, or waited until the end of the school year to do so.

[3] What Do We Know?: Seeking Effective Math and Science Instruction, Beatriz Chu Clewell and Patricia B. Campbell, Urban Institute, p. 3.

To address these challenges, MWM is working on a statewide dissemination strategy by gaining the support of the Maryland State Superintendent, as well as the state's 24 science coordinators. DOD is also contracting with Garrett County Community College to establish a statewide resource Center to help schools and teachers adopt MWM, and Garrett will also engage community colleges across the state (which already have hands-on working relationships with the school districts and individual schools).

This effort should move somewhat beyond the Army's traditional reliance on volunteers working school-by-school to promote AEOP programs. However, the three-year time horizon and multi-million dollar investment planned for the Maryland roll-out would indicate that sufficient resources will not be available to DOD to scale MWM to national impact on a state-by-state basis unless MWM succeeds in gaining broad sponsorship and substantial financial support from other STEM-based Federal agencies and science and technology-based companies. In addition to the high cost of the MWM expansion strategy, the time horizon for national impact would be many years.

Even as MWM overcomes the challenge of disseminating MWM effectively in one or more states, several elements of program success will remain in control of the teachers and schools adopting MWM, including the dosage/duration of the intervention. The MWM modules are estimated to take about 100 hours of total class time, and since they are most frequently used as a supplement to regular curriculum, even the most engaged teachers will use just a few modules per year. Other than providing MWM teachers with the best possible training, which MWM seeks to do, MWM has no control of whether and how teachers actually use MWM, and little impact on the level of adult engagement and personalization of the program. Some schools may include individualized mentoring and tutoring as part of their program, while others may not. In addition, to the extent that the students exposed to MWM improve their math and science achievement, it is going to be difficult to demonstrate that MWM caused the improvement.

A final possible challenge for MWM is that participating students do not necessarily see the connection between MWM and DOD science and engineering careers. In fact, many students may not be aware that DOD is funding the program. (Teachers and administrators will be aware that DOD is funding the MWM program, because they will have some degree of interaction with DOD volunteers). A key factor in overcoming this challenge will be whether MWM can develop a significant and meaningful role for its volunteers in the classroom. MWM anticipates calling on DOD volunteers to work with students in the classroom during the design phase of each MWM module, when students will, for example, create their own composites or sports materials, etc. MWM hopes this will be an opportunity for DOD volunteers to advise students on military science careers, and what it is like to work in a laboratory setting.

❑ Program Recommendations

Clarify Program Goals. Based on the MWM evaluation plan and dissemination strategy, it appears that MWM seeks to improve student achievement in math and science, as well as impact student attitudes toward science. The current stated goals are "strengthening the U.S. talent pool", and "increasing the numbers of domestic students pursuing math and science careers." The first of these is vague. It is unclear whether the second goal can be achieved by offering MWM through school-based experiences; special testing may be needed to determine whether MWM impacts the decisions and achievements of economically disadvantaged students and groups traditionally under-represented in science, engineering and technology.

Strengthen the Partnerships Among DOD Volunteers and Participating Schools. Maryland was chosen for a statewide roll out of MWM because of the significant presence of military laboratories and private military contractors in the state. Rather than utilizing this pool of prospective volunteers to introduce MWM to individual schools and teachers (as was done during the pilot phase, but which will be unnecessary, given the statewide dissemination strategy), MWM volunteers should be trained and used to visit schools to perform experiments with students.

Partner with Large States With a Significant Military Presence. If the launch in Maryland is successful, MWM should consider partnering with additional large school systems in states with a large military laboratory presence in the state. This will enable DOD to use the Maryland experience as a model for expansion in these states. Moreover, large school systems—such as California, New York, Texas and Florida—dominate K-12 education, and influence

curriculum adoption throughout the country, so partnerships with those states could serve as catalysts to adoption elsewhere.

Consider Partnering With a Commercial Publisher. In MWM, DOD has a high-quality product, aligned with education standards, with increasingly proven efficacy. However, DOD lacks the resources and marketing channels to disseminate this product nationwide in a timely and cost-effective fashion. DOD may want to consider engaging in discussions with commercial education publishers to explore how they might collaborate with DOD to disseminate MWM more broadly and faster.

❑ Recommended Goals

- Increase interest in science, math and technology among middle and high school students.
- Raise awareness and interest in science and engineering careers.
- Provide a strong link to DOD/Army scientists and engineers and the wide variety of interesting careers in military science.
- Encourage students to take advanced math and science courses in high school.
- Encourage students to attend college, and pursue majors in science, engineering or mathematics fields.

❑ Recommended Metrics

- Increased knowledge of the role of materials in every day life, based on pre and post-tests.
- Impact on student achievement based on pre and post-tests.
- Student attitudes toward the MWM experience, based on pre and post-tests.
- Student attitudes toward science based on pre and post-tests.
- Student self-confidence relating to scientific tasks, based on pre and post-tests.
- Level of interest in science and engineering careers, including military science careers, based on pre and post-tests.

GAINS IN THE EDUCATION OF MATHEMATICS AND SCIENCE (GEMS)

❑ Program Overview

Date established: 1992

Lead Army Organization: WRAIR

Management Structure: GEMS is overseen by volunteer researchers who are full-time scientists, and previously had one dedicated manager working under their direction.

Participating Organizations/Locations: 5

Walter Reed Army Institute of Research, Silver Spring, MD
Army Research Lab (ARL), Adelphi, MD
Army Research Lab, Aberdeen Proving Ground, MD
Aviation and Missile Research and Engineering Center (AMRDEC), Huntsville, AL
George Washington University, Washington, DC

Annual Budget: $500,000

- The $250,000 budget for WRAIR is currently supported by a grant from NIH's Science Education Partnership Award Program (SEPA) through August 2006.
- $250,000 is provided by ASAALT for expansion of GEMS to additional locations.

Target student population:

- GEMS 1: 8th through 12th grades
- GEMS 2: 10th through 12th grades
- GEMS 3: 11th through 12th grades
- "Disadvantaged" school districts, defined as lacking quality science-based activities and opportunities.
- Groups under-represented in science and engineering careers; however, other student groups are not excluded, and the GEMS program reflects local area demographics.
- Students must be located within commuting distance of a participating Army or university location.

Student selection:

- Candidates for the program are identified through their participation in the Washington, DC city-wide science fair.
- Students complete applications, and are encouraged to write essays.
- Students are selected based on enthusiasm, willingness to learn science, quality of written essays and teacher recommendations. Selection is not based on prior achievement.

Number of Students Served (2005): 218

Cost Per Student: $450 to $750, including payment of student stipends.

Growth Trajectory: GEMS is growing rapidly, as additional Army laboratories adopt the program.

- **Brief Program Description:**

One to four week programs are established for each summer in which younger junior/senior high school students perform short experiments illustrating basic scientific principles, while being guided by senior high school and college students, with the help of a full-time program administrator and a resident teacher for the summer.
The programs are designed such that successful students return in future summers to do even more sophisticated studies so that they may eventually become part of the 8-week Science and Engineering Apprenticeship and other advanced science activities. Research scientists, in conjunction with their college assistants, design age-appropriate protocols relating to current research.
Program directors and GEMS leaders also offer help to students with respect to guiding/working with parents, raising teacher expectations, aiding in SAT preparation, providing information for financial aid resources for a variety of educational services and tips for the college application process.
Students receive a stipend of $100 for each week of GEMS participation.

- **Program Goals and Objectives**

  - Identify science-enthusiastic youth from school districts lacking quality science-based activities and opportunities. Mentoring each student over an extended period of time and in various ways to nurture his or her interest in science.

  - Expose participating students to progressively more challenging lab experiences over multiple years to build each student's self-confidence in his ability to succeed in science and technology.

  - Demonstrate that learning is life-long, worthwhile, cool and fun.

  - Encourage students to attend college, and to continue their science education.

- **Program Promotion Methods and Responsibility:**

To date, most GEMS students have been recruited from the National Capitol Area. All students submitting projects to the DC city-wide science fair are invited to participate in GEMS. In addition, all National Capital Area middle schools are provided with program brochures, application materials, and instructions. GEM points of contact also reach out to teachers throughout the year, and connect to classroom activities.

GEMS brochures are disseminated at national scientific, Army and science outreach meetings.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: An annual evaluation is performed by an independent evaluator, as required by the terms of WRAIR's NIH grant.

Current program metrics:

- Growth in number of students participating
- Number of students who return to GEMS each year
- Number of students who transition from GEMS to SEAP (and become near peers)
- Expansion of program to additional laboratories and locations
- Student attitudes toward the GEMS experience, based on pre and post-tests
- Student attitudes toward science based on pre and post-tests
- Student self-confidence relating to scientific tasks, based on pre and post-tests

- Level of interest in military science careers, based on pre and post-tests

❑ Strengths and Challenges

GEMS is an informal science education program seeking primarily to excite and interest students from disadvantaged middle and high schools in science, and encourage these students to attend college, and select science and engineering majors. The GEMS model has several features that are aligned with best practice principles for informal science education:

Content: A variety of age-appropriate experiments have been developed to engage the students in fun hands-on activities. In addition, students are offered progressively more challenging and independent work as they move through the GEMS program each year, which serves to build their self-confidence, and help nurture an interest in studying more demanding science in school.

The pre and post-tests administered in connection with the most recent GEMS evaluation show that the GEMS participants overwhelmingly enjoyed performing experiments and working with other students in the laboratories. Therefore, the GEMS content would appear to enable the program to meet the goal of building students' interest in science. However, as other laboratories increase their participation in GEMS, it will be important for each laboratory to develop its own curriculum and experiments that best fit each laboratory's resources and culture.

Dosage/Duration: In addition, GEMS expressly seeks to engage and mentor students over a long period of time. Although it is possible for students merely to participate in a GEMS 1 program for a week and never to return, emphasis is placed on encouraging the same students to return year after year. In addition, highly-qualified GEMS students can advance to the Science and Engineering Apprenticeship (SEAP).

Among volunteers supporting the GEMS and SEAP programs, there was a strong consensus that it is far more valuable to give priority to returning students each year, rather than to serve more students for relationships of shorter duration. GEMS offers anecdotal evidence that a number of students who participate in GEMS for a few years are making choices to continue to engage in science education.

Engaged Adults: GEMS provides a good deal of adult support and encouragement for each GEMS participant, including scientist mentors, a resident teacher at each laboratory, and near peer mentors, who not only supervise the students' work, but serve as positive role models for the students.

Personalization: GEMS mentors appear to offer a good deal of support to GEMS students to encourage them to take challenging math and science courses in high school. This appears to happen on an informal basis, as the mentor/protégé' relationships develop. In addition, the near-mentors are an outstanding group, and their contributions to the students' experiences are significant. Moreover, the work of the near-peers takes some of the pressure of mentoring off of participating scientists.

Program challenges include the limitation on growth posed by the lack of adequate facilities to accommodate all interested students, and the high level of volunteer resources required to host young students in the laboratories. Unlike the SEAP program, in which students are integrated into the ongoing work of the laboratory, GEMS students are offered a somewhat artificial or contrived lab experience. This both adds to the work necessary to host a GEMS student, and may serve to discourage laboratory adoption and expansion of GEMS.

❑ Program Recommendations

Clarify Definition of Target Student Population. The stated goal of targeting students from "disadvantaged" school districts (those without quality science opportunities) is too vague. WRAIR has always applied that definition to justify selection of students from the District of Columbia. Instead, the Army may want to consider focusing on an objective definition of "economic disadvantage"—for example, the number of students in a school or district qualifying for free or reduced-cost school lunches—and open GEMS to all schools and school districts in the vicinity of participating Army labs that meet this objective definition.

Make Model Flexible for Transfer to Other Army Locations. The experience with expanding the GEMS model to other Army locations has demonstrated a need for greater flexibility in application of the GEMS program model to other locations. The efforts last summer demonstrate the difficulty in taking a cookie cutter approach to sharing *any* program across the laboratories. Some of the content developed at WRAIR was not easily transferable, and the security and facilities issues, as well as skills of the volunteer scientists, frequently dictated a different approach.

Rather than applying a "one-size fits all" approach to GEMS, the Army would benefit from preparing a set of "turnkey" guides (such as those used in eCYBERMISSION) to explain the overall program, and each volunteer's role in it. Then, each Army site should work to develop its own variation on the program, based on these standardized information pieces.

❑ Recommended Goals

- Identify science-oriented students from disadvantaged school districts.
- Offer students a progressive series of meaningful work experiences in Army laboratories over multiple years.
- Encourage students to take advanced math and science courses in high school.
- Encourage students to attend college, and pursue majors in science, engineering or mathematics fields.

❑ Recommended Metrics

- Number of GEMS pursuing advanced math and science studies in high school.
- Number of GEMS who transition from GEMS to SEAP (and/or become near peers).
- Number of GEMS who enter college.
- Student attitudes toward science based on pre and post-tests.
- Level of interest in military science careers, based on pre and post-tests.
- Number of GEMS who select science and engineering majors in college.

SCIENCE AND ENGINEERING APPRENTICE PROGRAM (SEAP)
COLLEGE QUALIFIED LEADERS (CQL)

❑ Program Overview

Date established: 1981

Lead Army Organization: Medical Research and Materiel Command (MRMC)

Management Structure: Overall program oversight for SEAP and CQL is provided on a volunteer basis by a full-time Army employee who is primarily assigned to other duties. Administrative support is provided by The George Washington University under contract.

Participating Organizations/Locations: 16

Army Research Lab (ARL), Adelphi, MD
Army Research Lab, Aberdeen Proving Ground (APG), MD
Army Research Lab, Sensors and Electronic Devices Directorate
Army Research Lab, Survivability and Lethality Analysis Directorate
Army Research Lab, Weapons and Materials Research Directorate
Communications-Electronics Research Development and Engineering Center
Edgewood Area, APG
Natick Soldier Center (NSC)
Research, Development and Engineering Command, Rock Island, Illinois
Redstone Arsenal, Alabama
Engineer Research and Development Center—Topographic Engineering Center (ERDC-TEC)
Army Medical Research Institute of Chemical Defense
Walter Reed Army Institute of Research, Silver Spring, MD
Armed Forces Radiobiology Research Institute (AFFRI)
Defense Threat Reduction Agency (DTRA)
Naval Health Research Center (NHRC)

Annual Budget: $353,539, including $215,000 for administrative costs
$1,668,403 for stipends (paid primarily through the research budgets of participating mentors)

Target student population:

- SEAP: Open to high school students, 9th through 12th grades.
- CQL: Open to undergraduate and graduate students.
- Generally, students must be located within commuting distance of a participating Army location.

Student selection:

- Students complete applications, including writing a personal statement. Students also must provide teacher recommendations, school transcripts and standardized test scores, if possible.
- Selection for SEAP is highly competitive, with only about one-third of applicants accepted for placement in an Army laboratory. At WRAIR, only about 10% of applicants are accepted.
- Students are selected based on their GPA, standardized test scores, teacher recommendations, quality of their personal statements, and their areas of interest.

- Students are screened on the above criteria by George Washington University. Final placement is dependent upon finding a match with an appropriate mentor.

Number of Students Served (2005): SEAP: 153
CQL: 206

Number of Mentors (2005): 190

Administrative Cost Per Student(2005): $265

Growth Trajectory: Participation of mentors has eroded over a number of years. The availability of appropriate mentors, as well as funding for student stipends, are the major limiting factors on future growth.

❑ **Brief Program Description:**

The Science and Engineering Apprentice Program (SEAP) is an eight week summer internship program for high school students. SEAP is designed so that students can apprentice in fields of their choice with experienced scientists and engineers on mutually agreed projects.

The College Qualified Leaders (CQL) program offers eight week summer internship opportunities to undergraduate and graduate students.
The program seeks to offer work that is meaningful to both the apprentice and the sponsoring organization, tailored to the interests and capabilities of the student, and to provide a personally rewarding learning experience. A mentor is assigned to each apprentice to provide project supervision and on-the-job instruction, and to encourage learning and development. This "hands-on" experience gives students a broader view of their fields of interest and shows students what kind of work awaits them in their future career. At the end of the summer, the students prepare final reports and present their research at a final seminar, held at George Washington University.
First year participants are awarded an educational stipend of $1,545. CQL students receive a stipend of $6,951.

❑ **Program Goals and Objectives**

Science and Engineering Apprentice Program

- Encourage students to pursue science and engineering careers.
- Acquaint qualified high school students with the activities of Department of Defense laboratories through summer science and engineering research experiences.
- Provide students with opportunities in and exposure to scientific and engineering practice and personnel not available in their school environment.
- Prepare students to serve as positive role models for their peers by encouraging other high school students to take more science and math courses.
- Develop a student/citizen appreciation for the process and rigor of scientific research.

College Qualified Leaders

- Provide SEAP mentors with the opportunity to have fully-trained students return to their laboratory during their college years.
- Give mentors the opportunity to share their passion for science with talented undergraduates.
- Give SEAP students the opportunity to continue their research and training.

- Educate undergraduates and graduates about the research process by performing actual research.
- Provide a learning community for the developing professional.
- Prepare a new generation of scientists and mentors.

❑ **Program Promotion Methods and Responsibility:**

George Washington University has responsibility for program promotion. Program materials and application forms are sent annually to local high school principals, science and mathematics department chairpersons, and superintendents of schools. Public, private and parochial schools located in the vicinity of participating laboratories are included.

In the National Capital area, application forms go out to many of the most prestigious local high schools, including Thomas Jefferson, Montgomery Blair, Sidwell Friends, Madeira, Richard Montgomery and Bannaker. Outside the National Capital area, Army points of contact recommend the high schools in their communities that should be contacted.

SEAP is also promoted on several web sites, including AEOP, GWU, ARL and WRAIR.

CQL opportunities are not advertised; students involved in CQL learn about them through either their own prior participation in SEAP or GEMS, or through word of mouth. SEAP/CQL management have chosen not to advertise more broadly because the programs already are oversubscribed every summer. In 2006, more than 1,200 applications were received, and about 350 are expected to be placed this summer in Army laboratories.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics:

- Number of students participating.
- Number of students and mentors returning to the program each year.
- Of the approximately 135 students accepted for the summer of 2006, virtually all are returning students, and many are in their second or third year.

Qualitative metrics:

- SEAP/CQL contributes to the work in progress and to meeting laboratory metrics.
- SEAP/CQL is perceived to provide an advantage in recruiting extraordinary candidates.
- SEAP/CQL generates much interest and good will among talented young people that the Army would be unlikely be able to attract otherwise, and improves community relations.

❑ **Strengths and Challenges**

SEAP is a mature, efficiently run, and apparently effective internship program. With the exception of SEAP students who become near peer mentors (and therefore, have a more standardized set of activities), the overall quality of the learning experience is highly dependent on the efforts of the mentors. However, the fact that many students return year after year, and build long term relationships with their mentors, would indicate that these relationships are functioning reasonably well.

Content: For the most part, the mentors we interviewed appeared to be providing meaningful, real-world research experiences to their apprentices. Most engaged the apprentices in their ongoing research to the extent possible, so there is a very good exposure to both military science as well possible career opportunities. However, finding projects appropriate for high school students was a challenge for some mentors, and many mentors indicate reluctance to work with high school students.

Dosage/Duration: A number of mentors suggested that an eight week program is too brief to provide the best possible research experiences to students, and that the short duration of the internship places an additional burden on mentors. Consideration should be given to extending the program to ten or twelve weeks for interested mentors and students, which appears permissible under DOD guidelines, which permit apprentices to work up to 1,040 hours per year throughout their high school and college years, so long as the work assignment is related to their studies.

Engagement, Personalization and Commitment: Perhaps the greatest strength of the SEAP/CQL program is the high level of adult engagement and personalization of the program, together with the passion and commitment of the SEAP mentors. Of the many mentors we interviewed, all believe passionately in nurturing the next generation of scientists and engineers, and most find a great deal of value in the work done by the apprentices. Each year, mentors give top priority to returning students because they see the importance of developing a continuing relationship with these students.

❑ Program Recommendations

Clarify Program Goals. The stated goals for SEAP vary depending upon laboratory location, and goals are stated differently on the AEOP web site than in SEAP/CQL presentations. In addition, some goals, such as "preparing students to serve as positive role models for their peers by encouraging other high school students to take more science and math courses," are probably overly ambitious, and cannot be measured. The program would benefit from having a few, very clear goals, all of which are tied to specific metrics.

Expand Program Within Existing Locations and To New Locations. This year, the SEAP program attracted 1,200 applicants with only minimal efforts at advertising, demonstrating that there is a clear student demand for hands-on research experiences in Army laboratories. Even at laboratories—such as WRAIR—that already accept a large number of students, there appears to be additional capacity to accept students.

One of the greatest deterrents to expansion at this point appears to be the requirement that each mentor fund the apprentice through his or her own research budget. In a time of declining research budgets, this has placed a great strain on individual investigators. Thus, over time, the number of participating mentors has declined, until what remains now is the core of the most dedicated SEAP mentors.

At low cost to the Army, this incentive structure could be changed. The total cost for each SEAP student averages $1,810, while the cost for a CQL student averages $7,216. The Army should consider partially subsidizing the cost of new SEAP/CQL apprentices during the first couple of years with a mentor. According to the current mentors, these students do such great work, that after an initial experience, mentors begin to find their apprentices indispensable, and choose to pay their stipends themselves. In addition, ASAALT should consider establishing overall expectations or guidelines for laboratories emphasizing the importance of creating student internship opportunities and mentoring within each laboratory.

Disseminate Information About SEAP/CQL Authorities Throughout Army S&T Community. SEAP/CQL provides a very flexible and inexpensive authority and set of rules that could support a wide variety of Army laboratory-based research experiences for high potential high school, undergraduate and graduate level students. However, the lack of awareness of this program could be limiting its potential reach, particularly in parts of the Army S&T community not currently fully engaged in AEOP programs, such as, for example the University Affiliated Research Centers. At least one of the UARCs has recently begun a project to foster opportunities for graduate and undergraduate students performing research at the Center to participate in summer internships at Army laboratories. Lack of knowledge of existing Army programs supporting summer internships—both within the UARC, and among Army points of contact working with the UARCs—was a significant barrier to creating an appropriate program in a timely manner.

Anyone in the extended Army S&T community should have prompt and easy access to the entire Army toolkit to create opportunities for the Army to access quality talent being trained at the UARCs. Since this knowledge was not available, the opportunity to benefit from high potential students referred by one of the UARCs was not available to the Army.

For CQL Students, Consider Eliminating Geographic Limitations to Opportunities.
Undergraduate and graduate students have much more ability to work at numerous geographic locations. Rather than limiting their opportunities to laboratories within commuting distance of their homes, CQL students should have the opportunity to work at a variety of locations across the Army S&T community, so long as they can make appropriate living arrangements during the term of their summer experience.

Consider Closer Linkage to Army Science and Engineering Workforce Needs. SEAP and CQL attract students who have high achievement levels in science, engineering and math studies. They are therefore a potentially fertile source of future Army scientists and engineers. Explicit attention should be paid to matching these students with appropriate mentoring and research opportunities throughout their college and graduate programs. In addition, the Army should consider advertising appropriate vacancies to this group, or make Army career opportunities known to the CQL students through web sites and other methods of communication.

❑ Recommended Goals

Science and Engineering Apprentice Program

- Identify high potential students.
- Offer students a progressive series of meaningful work experiences in Army laboratories over multiple years.
- Encourage high-potential students to take advanced math and science courses in high school.
- Encourage high-potential students to pursue majors in science, engineering or mathematics fields.

College Qualified Leaders

- Encourage high potential students to persist in STEM studies.
- Encourage high potential students to pursue STEM degree completion.
- Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
- Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

❑ Recommended Metrics

- Number of SEAP students pursuing advanced high school science and math courses.
- Number of SEAP students who return to the program each summer, or move from SEAP to CQL or other Army lab experiences (summer or school year).
- Pre and post-testing for attitude toward S&E careers.
- Number of SEAP students who enter college.
- Number of SEAP/CQL students who select science and engineering majors in college.
- Number of SEAP/CQL students graduating with a science or engineering degree.
- Number of SEAP/CQL students who become Army employees or military scientists or engineers.

UNINITIATES' INTRODUCTION TO ENGINEERING (UNITE)

❑ Program Overview

Date established: 1980

Lead Army Organization: ARO

Management Structure: Army personnel oversight; with Junior Engineering Technical Society (JETS) managing and coordinating program through program officers at individual college/university sites.

Participating Organizations/Locations: The program takes place on campuses of HBCU/MIs, the number of which vary. Currently there are 7 sites, including - University of New Orleans; Colorado State University; Florida International University; NJ Institute of Technology Women's Center; New Mexico University - MESA; University of Delaware; University of Detroit – Mercy

Annual Budget:
FY05: Total - $290,000; 7 sites ($30K/site) - $210,000; Administration - $80,000
FY04: Total - $200,000; 5 sites - $150,000; Administration - $50,000
FY03: Total - $170,000; 4 sites - $120,000; Administration - $50,000

Target student population:
Historically under-represented, and socially/economically disadvantaged high school students.

Student selection:
Application through the schools and university websites, determined by the university and its program coordinators. They may use wide latitude in selecting students

Number of Students Served:
FY05: 559 (7 sites)
FY04: 417 (5 sites)
FY03: 455 (4 sites)

Estimated Cost Per Student:
FY05: $519; FY04: $480; FY03: $374

Growth Trajectory: Starting in 1993, the scope of the UNITE program was expanded to freshmen and sophomores in high school, thereby identifying and supporting students throughout their four years of high school. JETS has been contractor for 20+ years. According to the contractor, during 1980s the Army considered cutting funding for UNITE; however JETS and the university sites lobbied Congress heavily and Army funding was retained.

❑ Brief Program Description:

UNITE aims to promote careers in engineering and technology at the high school level by providing students access to academic enrichment courses on college campuses. UNITE is designed to provide historically under-represented (socially/economically disadvantaged) high school students with summer class instruction that closely parallels that of a first-year student in a university engineering program. Through academic classes, hand-on activities, and team-based learning, the students explore the connections between math and science, and real world applications. Students also make visits to STEM organizations, including nearby Army installations (or other service branches if no Army location). A member of the ROTC addresses each site.

❑ Program Goals and Objectives

- Provide historically under-represented (socially/economically disadvantaged) high school students summer class instruction that closely parallels that of a first-year student in a university engineering program.
- Provide opportunity for exploration of the connections between math and science, and real world applications through academic classes, hand-on activities, and team-based learning
- Promote careers in engineering and technology at the high school level.

❑ **Program Promotion Methods and Responsibility:**

The contractor, JETS, has responsibility for national promotion; although it is unclear how valuable this is, given the requirements for university participation and the funding constraints. The promotion consists primarily of a page on the JETS website has one page; although currently no link to the AEOP website and some literature and pamphlets.

The Army's role is primarily information, included on the ARO and ARL and AEOP websites.

Individual university sites have responsibility for local promotion; although a brief search of selected university websites yielded little or no information: there is no listing on the University of New Orleans' website (either under the prospective student or science or engineering department sections; nor with a request in the university's search engine); the University of Detroit includes the UNITE logo on the bottom of its "internships" page, but not in the sidebar menu list of over 15 programs.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation:

- Grantee and site coordinators do follow-up assessments in standard format.
- Can dismiss and/or add other sites – seems to occur as result of numbers of students that university attracts annually: CO State supplanted Clarkson 3 years ago b/c Clarkson didn't maintain numbers. CO now may lose funds b/c such a small site (~20 students), and because there is suggestion to add CO funds to New Orleans b/c of pressures from Hurricane Katrina and b/c New Orleans does a great job with program.
- University sites chosen by virtue of being in the "heart" of the targeted population

Current program metrics:

- Annual number of students
- Percentage of enrolled students (75% are enrolled in or have attended college)
- Percentage of enrolled/graduates who maintain interest in STEM: 53% of participants who are in or have graduated from college have remained in the STEM disciplines.

The JETS contractor commented that JETS was in process of re-evaluating each stage of the program to consider outcomes and how the program could be more effective.

❑ **Strengths and Challenges**

UNITE only provides funds for programs that already exist; a potential site cannot use funds to start a new program. There is apparently some attention to the performance of individual sites, but only one instance of a site losing funding. It is not clear whether or not these sites were chosen from a larger pool of "applicants" at the beginning of program (20+ years ago), and/or whether other university sites in economically disadvantaged areas have expressed interest in participating.

The program is very limited in its geographical focus and (apparently) in its ability to expand. While the outcomes in terms of subsequent college attendance and continued interest in STEM, the per student cost appears to be somewhat high, relative to the fact that the program must already be in place.

It also is not clear what the Army gains from "owning" a separate program with attendant overhead. If the locations, universities and/or their programs are worthwhile, it may make more sense to fund the program directly, with the same level of Army branding and Army ROTC or lab visits.

The program is not well known and has no distinguishing characteristics that link it to the Army research enterprise; for this reason, there is no internal awareness of the program. Direct experience with any Army personnel or location appears to be irregular and, in cases in which there is no nearby Army facility, the connection may be to another one of the services. The contractor is a nonprofit organization with a number of functions and responsibilities and UNITE is only one among a number of programs that it promotes.

UNITE shares characteristics with both REAP – without the size or high achiever aspect – and GEMS – without the carefully developed and detailed structure of the experience, not to mention the focused attention of the GEMS founders. Because of its relative isolation from other AEOP programs, UNITE doesn't appear to offer an easy option as a pathway to other AEOP programs.

❑ Program Recommendations

- Meet with the contractor to discuss strategies for increased effectiveness and reach.
- Benchmark content, student participation, student satisfaction and cost against similar programs.
- Evaluate the performance of current university sites, according to outreach, promotion, student satisfaction, number of high schools reached, etc. as well as subsequent student education track.
- Publish a new RFP for application to UNITE, including current sites and potential new sites.
- Review management costs of contractor and universities.

❑ Recommended Additional Metrics

- Student satisfaction through pre and post testing
- Student learning via pre and post testing
- Student awareness of career options in Army and military and its contractors

❑ Program Overview

Date established: Summer Institutes – 1989; Service Academy Internships - 1998

Lead Army Organization: ARL HPCRC

Management Structure: Army lab personnel oversee the program, which is managed by participating university and/or Army lab. The program is headquartered at the University of Minnesota.

Participating Organizations/Locations: The AHPCRC partners include: Clark Atlanta, Florida A&M, Howard, and Jackson State Universities; the University of Minnesota; the University of North Dakota; and Network Computing Services, Inc. Four of these universities are HCBU/MI, with their participation funded using the Army's 10% set aside.

Annual Budget:
The Army funds the program, with major equipment acquisition provided by DoD's HPC Modernization Program.
HPCRC: $1.5M

Summer Institute (15 high school students for 2 weeks): at university - $50K per university or $300,000 total.
Advanced Summer Institute:
Service Academy Internship Program (military academy cadets for 3 weeks): at HPCRC labs.

Target student population:
Summer Institute: ~950 high school students competing for 15 slots*;*
Advanced Summer Institute: 15-20 undergraduate students for 10-weeks program + $3500 stipend.

Student selection: By individual application to the university or ARL HPC lab.

Number of Students Served:
Summer Institute: no totals available; number of participating universities varied by year.
Advanced Summer Institute: 212 (1991-2002)
Service Academy Internship Program: 2005 - 11; 2004 – 5; 2003 – 2.

Number of Teachers Involved: No information

Number of Adult Leaders: N/A

Cost per student:
Summer Institute: ~15 students @ $50K/university: $3,333
[dollar figure includes informal teacher participation, in some cases]

Growth Trajectory:
Program manager at one lab commented that could probably double the number of sites, but at that point would reach the capacity.

- **Brief Program Description:**

The AHPCRC is a government-university-industry partnership committed to helping maintain the Army and United States lead in HPC research, and providing future generations with the advanced tools and training they will need. The educational programs of the AHPCRC are designed to emphasize the use of HPC in research and its application to complex real-world problems. Through such programs, including its high school and undergraduate summer institutes, as well as its graduate research opportunities, students are encouraged to pursue advanced degrees focusing on computational sciences and engineering. The AHPCRC provides three types of internships designed to interest students – especially women and underrepresented minorities – in STEM and encourage them to consider careers in STEM research.

The ***Summer Institute*** is a two-week experience at a university site for approximately 15 students. The program is quite competitive, with approximately 950 applicants for 15 slots. The cost is $50K per university. The curriculum is the same across all universities for the first week; the second week, the curriculum is customized to the particular research focus of the university.

The ***Advanced Summer Institute*** hosts 15-20 undergraduate students for a 10-week program, which emphasizes the use of simulation and modeling, parallel computing, and graphics and visualization to solve real-world problems of interest to the Army. The Institute's purpose is not only to train students in these areas, but also to encourage them, especially women and minorities, to pursue graduate studies or careers in HPC. The Institute includes a $3500 stipend.

The ***Service Academy Internship Program*** is a three-week program, which offers military academy cadets participation in research projects taking place at the AHPCRC. Cadets work closely with AHPCRC staff scientists and other researchers in diverse areas such as computational fluid dynamics, computational solid mechanics, and computational chemistry. Students are trained in the use of high performance computing resources and numerical simulation tools, and then perform numerical simulations and analysis on engineering applications, which are relevant to the U.S. Army and the Department of Defense.

- **Program Goals and Objectives**

The educational programs of the AHPCRC are designed to emphasize the use of HPC in research and its application to complex real-world problems. Through such programs, including its high school and undergraduate summer institutes, as well as its graduate research opportunities, students are encouraged to pursue advanced degrees focusing on computational sciences and engineering.

Summer Institute: To interest students – especially women and underrepresented minorities – in STEM and encourage them to consider careers in STEM research.

Advanced Summer Institute: To train students in these areas and also to encourage them, especially women and minorities, to pursue graduate studies or careers in HPC.
The *Service Academy Internship Program*: Students are trained in the use of High Performance Computing resources and numerical simulation tools, and then perform numerical simulations and analysis on engineering applications which are relevant to the US Army and the Department of Defense.

"Teach the teacher": 2 week program for high school teachers, inaugurated in 2003 in Minneapolis and Aberdeen. The program provides teacher modules (such as cds and instructional material) that fit high school curriculum; as well as offering hands-on experience. They are then more able to "teach the teacher".

- **Program Promotion Methods and Responsibility:**

Summer Institute and Advanced Summer Institute: Universities promote to local schools and geographically eligible colleges/universities

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation:
Numbers of students for each program;
Data tracking for *Advanced Summer Institute* undergraduates:
Between 1991-2002 there have been 212 students. The program has data from 93 of them: 18 have gone on to study math; 14 to engineering; about 14 have gone to work for DOD or a government contractor.
Of the 93, 18 (35%) are African American; 10 are white; 4 Asian, not Hispanic.

Current program metric:
Numbers of student applicants
Advanced Summer Institute: Numbers of students who go on to study STEM and take jobs in DOD or government contractor.

- **Strengths and Challenges**

Anecdotal information that includes written and video material on student projects and participation suggests that each program is successful, but they are resource intensive and only the *Service Academy Internship* program is connected to Army labs.

Summer Institute: It is not clear whether or to what extent this program is successful, given that the goal does not require formal submissions by students, is primarily designed to "interest" students in STEM, and is restricted in tracking students at this age.

Advanced Summer Institute: The faculty work with these undergraduate and graduate students to interest them in going on – encourage them to get internship at Army lab the next summer, etc.

Service Academy Summer Internship: For those students who complete the program, there are additional research internship opportunities working one on one with scientists at Army labs or at Cray, Inc.

- **Program Recommendations:**

The overall recommendation here is to develop ways to reduce cost per student:

- Investigate the possibility of standardizing the week one "common" curriculum so that it may be used more than one year.

The high cost per student - over $3,000 – includes the curriculum, both the common curriculum developed for use by all universities in week one, and the curriculum customized to individual university capabilities for week two, changes from year to year and therefore the cost cannot achieve cost savings over time.

- Explore costs of university management, with a view to possible savings by collaboration on promotion materials or other aspects.
- Consider the impact on student application and participation in the Advanced Summer Institute if the $3500 stipend were reduced.

- **Recommended Metrics: N/A**

RESEARCH AND ENGINEERING APPRENTICE PROGRAM (REAP)

❑ Program Overview

Date established: 1979

Lead Army Organization: Army Research Office/Youth Science Programs

Management Structure: Oversight by Army program manager, with organization and management provided by external contractor, the Academy of Applied Science

Participating Organizations/Locations: 54 colleges/universities

❑ *Annual Budget:*

FY03: Total - $340,000; Student awards - $247,000; Administration - $93,000
FY 04: Total - $352,000; Student awards - $247,000; Administration - $105,000

The Army's budget provides a $2600 stipend for each student, totaling 95 grants per year. Universities waive overhead. Most of the participating universities receive funding for one student stipend; although a few have two students. In the absence of additional funds for stipends, adding a new university requires transferring a student slot from a university with two.

Target student population: High school seniors, rising seniors and rising juniors in historically underrepresented groups

Student selection:

The basic criterion for selection of participants is the potential shown for pursuing careers in science and engineering. Factors considered in the selection process include:

- previously demonstrated abilities and interests in science and engineering;
- potential for a successful career in the field as indicated from overall scholastic achievement, aptitude and interest areas
- recommendations from high school teachers and/or administrative personnel
- interviews with prospective participants
- residence within daily commuting distance of the work; although sponsors/universities are free to provide special transportation within legal limits.

University selection:
The contractor (AAS) identifies and evaluates current and prospective sponsoring university institutions and mentors, and selects those that can provide the best opportunity to ensure program success. An institution may be awarded more than one grant and, accordingly, a mentor may oversee more than one apprentice.

Number of students served:
FY03: 138
FY04: 104
Universities and other organizations are free to raise additional funds for students to participate in the program, so the totals are greater than the 95 students funded by the Army.

Administrative Cost per Student:
FY03: $978.95
FY04: $1,105.26

Growth Trajectory:

The number of students applying has increased over years; although the majority of the participating universities has not changed. Three universities were added in 2005/6, as a result of unsolicited inquiries. One had previously been a REAP site.
The initial list of universities was those with Army programs; now they must be Army contractors (individual researchers/mentors don't need to be contractor, however). Expanding the number of participating universities would require a zero-based RFP promoted to a broader pool of universities (without additional program funds).

- **Brief Program Description:**

REAP provides underrepresented high school students interested in science and engineering the opportunity to participate as apprentices in summer cooperative work-study and research programs in university labs. The apprenticeship includes hands-on experience in research and development activities.

High school students accepted for apprenticeships are be paid during work periods and work directly under a mentor scientist or engineer, who provides guidance on day-to-day job activities, as well as assisting in providing information on career opportunities in science and engineering. The mentor has the discretion to use his/her portion of the grant funds to pay other research assistants for services rendered in accomplishing the program.

Although designed primarily as a summer program, once the student is brought into the program, his/her progress and association with the sponsoring institution will be encouraged on a continuing basis, hopefully through college as he/she becomes eligible for other programs such as co-ops or internships. The program at the institution may be continued through the winter as an after-school job to ensure that the apprentice's motivation is maintained.

- **Program Goals and Objectives**

The ultimate REAP objective is to ensure the availability and improve the quality of people who are qualified and oriented to perform professional and support work in defense life and physical sciences, by:

- Providing a cooperative education (work/study) program of mentor/apprentice sciences interaction for high school students who are historically under represented in the science, mathematics, engineering and technology fields;
- Offering hands-on experience in research and development activities to students to encourage their continued education in the science, mathematics, engineering and technology fields;
- Exposing students to science experience not readily available in high school;
- Providing the students an opportunity to work cooperatively with scientists actively engaged in research.

- **Program Promotion Methods and Responsibility:**

Contractor Promotion to Universities:
REAP is advertised through website, pamphlets, presentations, conferences.
The contractor provides pamphlets, brochures, fact sheets, and its newspaper
According to the contractor, because the number of grants is static, AAS is not allowed to promote the program beyond existing universities; although universities occasionally approach the contractor with requests to participate.

Universities Promotion to High Schools:
Universities typically develop and maintain relationships with area high schools through letters to the school science teachers and guidance counselors, who return applications of interested students.
[Survey sample demonstrates range in locations: "2005: 103 applications from different high schools"; serving ten or more schools that are within driving distance of the university

- **Data/Outcomes/Other metrics:**

Formal or informal evaluation: Annual summary evaluation developed from mentors and university site coordinators; the summary for FY05 not yet available.

Within thirty (30) days after conclusion of the apprenticeship, the mentor submits to the university a narrative letter report on each student employed as part of this program. The report must indicate the type and level of work performed by the student and an evaluation of the student's performance as well as comments and suggestions on this effort.

Current program metrics:
Number of students who enter college and remain in science, mathematics, engineering and technology disciplines. Approximately 90 percent of REAP participants go on to pursue further education in science, mathematics, engineering, and technology disciplines

Qualitative metrics:
Note: The AEOP program manager for REAP sent a survey to each of the university contacts with request for written responses from which 9 were received and tallied. Some of the pertinent comments follow:

Comment from one survey respondent:
Each student has expressed a deep appreciation for the exposure to the university environment. Apprentices from the 2004 program have since enrolled at the university, one in the host department (chemistry).

In addition to "satisfaction" measures, about 1/3 of the sample of 9 university surveys noted additional "performance assessment" measures, including:
- ✓ students must create end products; these products have been papers and oral presentations
- ✓ students and their advisors to make a presentation about their projects. This year I will suggest them to come back in March for a University-wide research conference.
- ✓ I view the project as successful when it reaches the stage at which a refereed research publication results.

❑ Strengths and Challenges

REAP is well-established and known among the universities and high schools that participate; although the contractor believes that Army personnel – even in locations near the universities – do not participate in any aspect of the program, and apparently have little awareness of it.

The hallmark of this program is the one-on-one mentor component, and the program states detailed requirements for mentor's responsibilities. The decision on mentors is left to the university, which a request to provide guidelines to all sponsors and mentors to maximize use of time of the apprentice's time. It is not clear, however, how effective the mentor relationship is, given the lack of data from university program managers about the individual mentors. There also is no data available about whether the mentors remain the same year after year, are evaluated regularly via student "exit" surveys/interviews, or receive any training/guidance in their first few years of serving as a mentor.

Although designed primarily as a summer program, once the student is brought into the program, the program guidelines recommend that "his/her progress and association with the sponsoring institution be encouraged on a continuing basis, hopefully through college as he/she becomes eligible for other programs such as co-ops or internships." Anecdotal evidence from several survey respondents note individual cases of such continuation into degree programs. The program at the institution may be continued through the winter as an after-school job to ensure that the apprentice's motivation is maintained.

❑ Program Recommendations:

Review and revise, as necessary, criteria and evaluation for university participation:
- Review evaluation process, including existing templates and value of additional criteria and pre/post interviews with students about expectations and realities of the experience. Stipulate to universities that evaluations must be completed in requisite detail in order to remain in good standing.
- Develop list of optimum pool of potential universities, without regard to current participants, in order to determine if there are universities with significant presence and influence among under-represented populations that are not aware of REAP and that are eligible for inclusion.

Solicit recommendations from university POCs, mentors, and students (to the degree this is feasible) for improvements in the effectiveness and efficiency of the program.

- Develop and promote process and materials that existing REAP universities and potential REAP universities can use to solicit funds from business and/or other funding organizations to support additional apprentices.

Increase Awareness of REAP among Army personnel and develop methods to expand the Army branding of the program, particularly among students:

- Request that appropriate Army personnel sign the "welcome" and "congratulations" letters that are sent to each student by the contractor.
- Enclose information on Army R&D and potential careers in these mailings.
- Institute personal communication to Army locations that are within commuting distance to participating universities, to encourage at least one visit by Army personnel to the university lab to meet student and mentor.
- Develop a fact sheet about REAP for distribution to contiguous Army locations (and for inclusion in potential AEOP "joint marketing" packet, that includes data on the subsequent degree and career choices of individual students.

Develop suggested "career path" options for REAP students among AEOP and related education programs:

- Request exchange of information between Army-supported university R&D - UARCS, Centers of Excellence, Collaborative Technology Alliances, and other HBCU/MI universities that have relationships with Army installations – and REAP to consider potential collaboration in terms of providing opportunities for students who complete REAP.

- Make connections between JSHS and REAP explicit. Several programs are in same universities as JSHS, and some of the REAP students have gone on to JSHS

❑ **Recommended Metrics:**

- Numbers of students whose subsequent interest in STEM is encouraged by participation in REAP.

- Numbers of high schools that are involved in REAP outreach.

- Degree of engagement of community, in terms of potential business or private sector funding for additional students.

CONSORTIUM OF UNIVERSITIES OF THE WASHINGTON METROPOLITAN AREA (CUWMA)

❑ Program Overview

Date established: 1981 by ARI and the Consortium

Lead Army Organization: Army Research Institute

Management Structure: CUWMA is managed by a full-time Consortium Director, who is a contract employee. The Consortium Director is supported by two additional full-time contract employees.

Participating Organizations: 5

Locations: 16

Army Research Institute—9 locations: Arlington, VA; Ft. Knox, KY; Boise, ID; Ft. Bragg, NC; Suffolk, VA; Ft. Leavenworth, KS; Ft. Benning, GA; Ft. Rucker, AL; and Orlando, FL.
Defense Manpower Data Center—2 locations: Rosslyn, VA and Seaside, CA
National Defense University, Ft. McNair, Washington, DC
Air Force Research Laboratory—3 locations: Wright-Patterson AFB, Ohio; Mesa, AZ; and San Antonio, TX
Office of the Under Secretary of Defense (Personnel and Readiness), Arlington, VA

Participating Universities Include:

American University
The Catholic University of America
Gallaudet University
George Mason University
The George Washington University
Georgetown University
Howard University
Joint Military Intelligence College
Marymount University
National Defense University
Southeastern University
Trinity College
University of the District of Columbia
University of Maryland, College Park

Annual Budget:
FY 2004: $1,539,000
FY 2005: $2,027.000 (as of August 25, 2005)

Target student population:

- Graduate and undergraduate students enrolled in degree-granting programs in information technology, and the social, behavioral and computer sciences.
- Several HBCU/MIs participate in the program, and approximately 24% of students who have completed the program are minorities.
- Students must be U.S. citizens.

Student selection:

- Interested students may apply at any time by submitting a cover letter, current resume' and two letters of recommendation from faculty. Students must be enrolled in a degree program, in good academic standing.
- After screening by the Consortium Director, candidates are interviewed and selected by prospective mentors.

Number of Students Served:

- ***Overall program:*** The program has served 1005 students over its 25 year history.
  Currently on Board (2006): 110 Research Fellows

- ***At ARI:***

Number of students:	45 in 2006
Number of mentors:	34 (as of August 2005)
Number of faculty:	19
ARI Locations:	8
Number of universities:	27 in FY 2004

Cost Per Student:
FY 2004: $32,000
FY 2005: $33,000

Growth Trajectory: CUWMA is a mature program, which appears to have experienced modest growth in recent years.

❑ **Brief Program Description:**

The Consortium Research Fellows Program at ARI is open to graduate and undergraduate students enrolled in degree-granting programs in information technology, and the social, and behavioral sciences. Each research fellow is assigned to a government mentor. The research fellows perform a variety of technical and analytical duties, such as literature reviews, design and/or administration of survey instruments, data collection and analysis, and preparation of research reports. Each fellow's schedule is flexible, and is worked out individually between student and mentor. Fellows may work up to 20 hours per week during the school year and 40 hours per week in the summer. Work sites are in Arlington VA and a number of field elements across the country.

There are four types of research fellows:

- **Consortium Research Fellows** (graduate students) are placed on research teams at sponsoring agencies to provide technical and analytical support while receiving training and experience in the theory and practice of their chosen future professions.

- **Consortium Research Assistants** (undergraduate students) function similar to fellows but are given less demanding tasks and more guidance.

- **Post-Doctoral Fellows** (full-time recent Ph.D.s) work full time for one or two years on specific projects for ARI.

- **Senior Consortium Research Fellows** (faculty consultants) complete short-term, task-specific research for sponsors.

Fellowship appointments are for a minimum of one year and a maximum of three years. Fellows earn between $16,445 and $33,345 per year for up to 1,300 hours of service.

❑ **Program Goals and Objectives**

- Provide educationally-relevant professional research experiences for undergraduate and graduate students.

- Provide high-quality technical and analytical support to sponsoring agencies.

- Groom a new generation of scientists, who either directly as government employees, or indirectly as contractors, will support Department of Defense R&D in the future.

- Provide research opportunities for faculty.

- Encourage fellows to complete their undergraduate and graduate degrees.

❑ **Program Promotion Methods and Responsibility:**

ARI has responsibility for promoting the Consortium Research Fellows Program. The program is promoted through the AEOP web site, through the CUWMA web site (www.consortium.org), and through web site links to all participating colleges and universities. Brochures and fact sheets for CRFP also are distributed by participating universities.

CUWMA also has long-term relationships with individual faculty members, many of whom recommend students year after year. In addition, the Consortium fellows we interviewed told us that some of their universities (for example, George Mason) have a strong and established network through which the students share information about opportunities among themselves. At other universities, such as Howard, awareness of ARI opportunities is more limited.

❑ **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics: (Currently tracked informally)

- Number of Consortium students completing advanced degrees.
- Number of Consortium students joining ARI as researchers.
- Number of Consortium students entering government service.
- Number of Consortium students jointly publishing articles and papers with ARI researchers.
- Of the 1005 students who have participated since 1981, approximately 90% have completed their degrees.
- 18 Research Fellows have been hired by ARI.

❑ **Strengths and Challenges**

The Consortium program is strong overall, and well-adapted to ARI's recruitment and research needs. The program seems to be effective at creating win-win opportunities for student participants, individual ARI researchers, and the institution as a whole. The program also is having an impact, with 18 former fellows working at ARI, a number of others electing government service, and most fellows completing advanced degrees. While it is impossible to determine conclusively that that program was the cause for this record of degree completion (as opposed to attracting serious students who were already on track to complete advanced degrees), the record is nevertheless impressive.

Some of the key strengths include:

Content: The Consortium fellows seem to be presented with challenging content, based on real-world Army research. Many students publish their results jointly with Army researchers, and accomplish their Master's thesis or doctoral dissertation using research performed during their fellowship. Importantly, most of the mentors we interviewed felt strongly that the students make an extremely valuable substantive contributions to their work.

Personalization and Engagement: Participating students have the opportunity to perform in-depth work under the guidance of experts in the field. According to the students, the relationships with the mentors are outstanding overall. There have been a few mentors over the years who are inattentive to their students or difficult to work with, and students have voted against those mentors with their feet, and shifted to other mentors.

Dosage/Duration: The continuity of relationships with fellows—which may last up to three years—is a key strength of CUWMA. The high number of students who return annually demonstrates that the students value the mentoring and research opportunities.

A key reason for the success is no doubt the work of Dr. Robert Ruskin, who works overtime to develop relationships at feeder universities that ensure a flow of quality students into the program, as well as to find the right match of student and mentor, and to oversee that day to day mentor/fellow relationships to ensure they are running smoothly. However, this also could put the future of the program at risk, as the current success and impact of the program, as well as the entire knowledge base of how the program runs, rests with him.

❑ Program Recommendations

Broaden Recruitment Efforts at Participating Universities. Currently, students are recruited largely as a result of long-standing personal relationships between the Consortium Director and individual faculty members at participating universities. Many of the participating students told us they learn of the program through word of mouth, and that some participating universities are much better than others at getting the word out. Procedures should be put in place at participating universities to reach out to a larger pool of students in order to attract the best applicants.

Create More Transparent Eligibility Requirements. CUWMA's requirements that students be enrolled and in good standing are vague, and seem to leave a lot of discretion to referring faculty, the Consortium Director and participating mentors. The Army might consider creating and advertising clearer eligibility requirements, and creating a more transparent process for application and acceptance.

❑ Recommended Goals

- Encourage high potential students to persist in STEM studies.
- Encourage high potential students to pursue STEM degree completion.
- Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
- Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

❑ Recommended Metrics

- Number of Consortium fellows graduating with a science or engineering degree.
- Number of Consortium fellows joining ARI as researchers.
- Number of Consortium fellows who become Army employees, military scientists or engineers.
- Number of Consortium fellows entering public service.

CAREER-RELATED EXPERIENCE IN SCIENCE AND TECHNOLOGY (CREST)

❑ Program Overview

Date established: Established as a pilot project in 1997.

Lead Army Organization: Research Development and Engineering Command (RDECOM)

Management Structure: The program is managed internally by one of RDECOM's human resources divisions.

Participating Organizations/Locations: 10

Natick, MA
Aberdeen Proving Ground, MD
Rock Island, IL
Ft. Monmouth, NJ
Warren, MI
Huntsville, AL
Orlando, FL
Army Research Lab, Adelphi
Picatinny Arsenal, MJ
Ft. Belvoir, MD

Annual Budget: $175,000-$200,000

Target student population:

- Undergraduate and masters' level students with majors in engineering, mathematics or computer science.

Student selection:

- Applicants must be enrolled as full-time students in good standing.
- Applicants must be U.S. citizens, and successfully complete a background investigation to obtain a secret security clearance.
- Applicants must major in a field of engineering, mathematics or computer science for which the Army is recruiting.
- Undergraduate students must successfully complete their years with a minimum GPA of 2.5.
- Graduate students must be accepted into graduate school and starting the first year of graduate study.
- Students must be capable of arranging a work schedule in such a way that a minimum of 640 hours of work at Army facilities is achieved prior to degree completion.
- Students must be prepared to accept conversion to an Army Internship within 120 days after degree completion.

Number of Students Served: 44 students currently enrolled. 600-700 students have participated over the past 10 years.

Administrative Cost Per Student(2005): No direct costs because managed within the human resources department's base workload.

Growth Trajectory: This is a steady-state program.

❑ Brief Program Description:

CREST is a program to recruit student engineers and scientists as future leaders in areas of military importance by providing summer and part-time employment (to include employment during school breaks), and an opportunity for an engineer or scientist position in the Army Intern Program.

Each full-time student is provided with an Army sponsor who works with the student to develop a work experience in each student's area of expertise, which will not interfere with that student's academic performance. Each Army sponsor serves as a mentor, establishes personalized objectives with the student, and reviews the student's performance annually.
CREST utilizes the government-wide Student Career Experience Program (SCEP), which provides a flexible authority under which students can be hired into positions that are related to their academic fields of study. Students enrolled or accepted for enrollment as a degree-seeking student in an accredited high school, technical or vocation school, 2-year or 4-year college or university, or graduate or professional school are eligible for the program. Participants who successfully complete their coursework leading to a diploma, certificate or degree, and who successfully perform at least 640 hours of work, may be non-competitively converted to term, career, or career-oriented positions.

❑ **Program Goals and Objectives**

- Meaningful engineering and scientific work experiences at Army research, development and engineering centers or related organizations.
- Work experiences are directly related to students' career goals.
- To provide an opportunity for direct conversion to a position in the Army Intern Program upon completion of a Bachelor or Master of Science degree.
- Progression to a position as an Army Engineer or Scientist with successful completion of the Intern Program.

❑ **Program Promotion Methods and Responsibility:**

The program is promoted through the AEOP web site and the RDECOM web site.

❑ **Data/Outcomes/Other Metrics:**

- ***Formal or informal evaluation:*** None provided.
- ***Current program metrics:*** None provided.

❑ **Program Recommendations**

Consider Broader Use of SCEP Authority. CREST is one of several programs directed toward creating positive work experiences for undergraduate and masters-level students. The program is the only one in the AEOP portfolio, however, that utilizes the government-wide SCEP authority. SCEP is a very flexible and versatile authority that enables students of all levels—high school, undergraduate and graduate students—to participate in meaningful work experiences on a part-time basis during the academic year. Successful students can be offered non-competitive conversion to full-time positions. Broader use of this authority might create more flexibility and benefit in some of the other programs.

❑ **Recommended Goals**

- Encourage high potential students to persist in STEM studies.
- Encourage high potential students to pursue STEM degree completion.
- Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
- Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

❑ **Recommended Metrics**

- Number of CREST students completing undergraduate-level degrees in science, engineering or mathematics.
- Number of CREST students completing masters and graduate-level degrees.
- Number of CREST students who become Army interns.
- Number of CREST students who become Army employees, or military scientists or engineers.
- Number of CREST students entering public service.

SCIENCE & TECHNOLOGY ACADEMIC RECOGNITION SYSTEM (STARS)

❑ Program Overview

Date established: 1997

Lead Army Organization: Army Research Laboratory (ARL)

Management Structure: Managed by ARL employees.

Participating Locations: 6

Adelphi, MD
Aberdeen Proving Ground, MD
Research Triangle Park, NC
White Sands Missile Range, New Mexico
Cleveland, OH
Langley, VA

Annual Budget: $400,000 committed at program's peak.

Target student population:

- Undergraduate seniors in good standing at Historically Black Colleges or Universities or other Minority Institutions.

Student selection:

- Applicants must be U.S. citizens.
- Applicants must be enrolled in a fully accredited higher education institution which is a Historically Black College or University or other Minority Institution.
- Applicants must be classified as a senior at the end of the semester for which he or she applies to the program.
- Applicants must have a grade point average of 3.0 or higher on a 4.0 scale at the time of the application.
- Continued participation in STARS requires students to maintain a 3.0 grade point average during the entire period of enrollment in the program, and to receive satisfactory performance reviews for all periods when the student is working under the guidance of an ARL mentor.

Number of Students Served: 27 students have served as fellows since 1997.

Administrative Cost Per Student(2005): Not provided.

Growth Trajectory: STARS is a steady-state program.

❑ Brief Program Description:

The Army Research Laboratory (ARL) STARS program was designed to assist ARL with maintaining a world class team of scientists and engineers with advanced degrees in highly competitive research areas, while simultaneously continuing to enhance the diversity of the ARL professional team. The STARS program helps to identify and recruit exceptional students that are enrolled in a science, engineering, or mathematics curriculum at Historically Black Colleges or Universities and/or other Minority Institutions (HBCU/MIs).

Students participating in the STARS program receive tuition assistance and a paid-internship as they progress professionally within the ARL workforce. Students in the STARS program will receive up to $30,000 per year for two years of their graduate study. During the summer, students are given the opportunity to work with an ARL research team on career-related projects of technical relevance to the ARL mission. Each student enters into a mentor/protégé relationship with an ARL senior research scientist, who will assist in the student's professional development.
Successful completion of the program may lead to a career-conditional position within ARL.

- **Program Goals and Objectives**

  - The overall objective of the STARS program is to alleviate the projected future shortfall of graduate (Master's) level scientists and engineers by targeting the underutilized groups of students at HBCU/MIs.

- **Program Promotion Methods and Responsibility:**

The program is promoted through the AEOP web site and the ARL web site, through ARL's Educational Partnership Agreements, and through attendance at career fairs and conferences.

- **Data/Outcomes/Other Metrics:**

  - ***Formal or informal evaluation:*** None available.

  - ***Current program metrics:***

  - Of the 27 students who have participated in STARS since 1997, 14 completed graduate science, mathematics or engineering degrees.

  - 10 former STARS fellows remain in government employment.

- **Recommended Goals**

  - Encourage high potential students from under-represented groups to persist in masters and graduate-level STEM studies.
  - Encourage students pursuing STEM degree studies to seek employment in military-related science and technology organizations.
  - Develop well-trained students who can meaningfully assist Army scientists and mentors in the fulfillment of Army missions.

- **Recommended Metrics**

  - Number of STARS students completing masters and graduate-level degrees in science, mathematics or engineering.
  - Number of STARS students who become employees of the Army, or Army academic and contractor partners.
  - Number of STARS students entering public service.

FACULTY RESEARCH AND ENGINEERING PROGRAM (FREP)

❑ Program Overview

Date established: Unclear. Likely during the 1970s.

Lead Army Organization: ARL—Army Research Office

Management Structure: Oversight by an ARL employee, with administrative functions and support provided by Battelle, Chapel Hill Operations.

Participating Army Organizations (2005): 4

Army Research Lab—APG: 3 Faculty members
ARL—Adelphi: 1 Faculty member
Ft. Sam Houston: 1 Faculty member
Ft. Rucker: 1 Faculty member

Participating Universities: 6

Michigan Tech
University of Texas
Purdue University
Catholic University
Texas A&M Kingsville
Alabama A&M

Annual Budget (2005): $144,613, paid for by the individual Army investigators who sponsor the faculty members.

Target population:

- U.S. citizens who are faculty members working at an American college, university, or technical institution as a full, associate, or assistant professor.

Participant selection:

Government organizations prepare and post Statements of Work for projects on which they are interested in receiving assistance. Interested professors complete an online application, and submit it, along with a current resume. Qualified faculty are selected and paid by the sponsoring organization.

Number of Faculty Served (2005): 7

Cost Per Faculty Member (2005): $20,659

Growth Trajectory: Utilization of the program has declined significantly in recent years. A decade ago, the average annual participation was at least 30 faculty members annually.

❑ Brief Program Description:

FREP offers university and college professors opportunities to collaborate with government scientists on short term technical projects at government laboratories at any time during the year. A research effort of up to 60 working days may be planned over the course of a one-year period of performance. FREP also allows for the location of the research effort be split between the government lab and the faculty member's home office.

Sponsoring organizations develop Statements of Work, for which qualified faculty apply. ARO (through its Scientific Services Program) negotiates a cost proposal and sends it to ARO for award. Work may commence once ARO awards the task.

The daily rate for FREP participants is based on a graduated schedule: Assistant Professors--$250 per day; Associate Professors--$290 per day; Full Professors--$330 per day. In addition, travel expenses to and from the laboratory and per diem are reimbursed in accordance with the current Federal Travel Regulations.

A final report is the end product of the effort.

- **Program Goals and Objectives**

  - To advance government scientific and engineering research, and provide university faculty with a hands-on experience in a government laboratory.

- **Program Promotion Methods and Responsibility:**

HSSMFP is promoted through the Army Research Office web site, the Army's AEOP web site, and word of mouth. All projects must be initiated by the government sponsor.

- **Data/Outcomes/Other Metrics:**

Formal or informal evaluation: None available.

Current program metrics: None available.

- **Strengths and Challenges**

This is a small program, which appears available to supplement a variety of other authorities under which laboratories may host college or university faculty at Army laboratories to engage in collaborative research. Currently, FREP seems to be used to fund projects of interest to an individual researcher and faculty member that may not fit under other authorities (such as ongoing programs of research through a Center of Excellence or Collaborative Technology Alliance, in which university faculty routinely work at Army laboratories).

- **Program Recommendation**

Eliminate Program from AEOP Portfolio or Restructure to Link Directly to AEOP-Branded Programs. Clearly, creating research opportunities for faculty to perform hands-on research in an Army laboratory is an important way to familiarize them with Army research, and military science career opportunities that may be available to their students. This experience no doubt would make these faculty more knowledgeable and effective advocates for Army research and programs. However, there currently appears to be no linkage between these activities and any STEM education programs the Army sponsors for undergraduate students (such as CQL or the Army Intern Program).

Because individual investigators fund the salaries of the faculty they sponsor (plus a 6% processing fee charged by ARO), additional funding would be required if the Army were to offer research experiences to faculty who support AEOP programs. Given other program priorities, devoting funds for this purposed cannot be a top Army priority. Should adequate resources become available, the Army should use the FREP authorities to create close linkages to the Army's student internship programs.

ARMY HIGH SCHOOL SCIENCE AND MATHEMATICS FACULTY PROGRAM (HSSMFP)

❑ Program Overview

Date established: Unclear. Likely during the 1970s.

Lead Army Organization: ARL—Army Research Office

Management Structure: Oversight by an Army employee, with administrative functions and support by Battelle, Chapel Hill Operations.

Participating Organizations/Locations (2005): 5

Natick Soldier Center (NSC): 3 teachers
Tank Automotive Research Development and Engineering Center (TARDEC): 1 teacher
Army Medical Research Institute of Infectious Diseases (AMRIID): 1 teacher
Walter Reed Army Institute of Research (WRAIR): 1 teacher
Engineer Research and Development Center (ERDC): 1 teacher

Annual Budget (2005): $64,050, paid for by the individual Army investigators who sponsor the teachers.

Target population:

- U.S. citizens who are faculty members of accredited high schools or secondary schools from the 7th to 12th grades and teach in one or more of the following disciplines: mathematics, physics, general science, engineering, chemistry, psychology, computer science or biology.

Participant selection:

Interested teachers complete an online application, and submit it, along with a current resume. Qualified teachers are selected and paid by the sponsoring organization.

Number of Teachers Served (2005): 7

Cost Per Teacher (2005): $9,150

Growth Trajectory: Utilization of the program has declined significantly in recent years. A decade ago, the average annual participation was at least 30 teachers annually.

❑ Brief Program Description:

ARO has established an expedited and flexible contracting process to allow laboratories to host high school teachers over the summer or during the school year. Sponsoring organizations develop Statements of Work, for which teachers apply. ARO (through its Scientific Services Program) negotiates with the teacher, and awards a task order.

The work may be in any area of interest to DOD. Specific tasks often include:

- Studies, analyses and assessments
- Laboratory basic and applied research
- Human performance and man-machine interface measurement and evaluation
- Test and evaluation of materials, components and systems
- Support of conferences, symposia and workshops, and technical consulting.

Contracts are awarded for a maximum of 60 working days over a maximum period of 12 months. The daily rate for HSSMFP participants is $175 per day. Commuting expenses, travel, and per diem are not reimbursable.

A final report is the end product of the effort.

❑ Program Goals and Objectives

- To advance government scientific and engineering research, and provide 7th to 12th grade teachers with a hands-on experience in a government laboratory.

❑ Program Promotion Methods and Responsibility:

HSSMFP is promoted through the Army Research Office web site, the Army's AEOP web site, and word of mouth. All projects must be initiated by the government sponsor.

❑ Data/Outcomes/Other Metrics:

Formal or informal evaluation: None available.

Current program metrics: None available.

❑ Strengths and Challenges

This is a very small program, which appears to operate well under the radar screen for most of the AEOP program managers and volunteers we interviewed. Currently, this seems to be a vehicle for funding one-of-a-kind projects of interest to an individual researcher and teacher, rather than a strategic tool for promoting Army education and outreach.

❑ Program Recommendation

Eliminate Program From AEOP Portfolio or Restructure to Link Directly to AEOP-Branded Programs. The goal of providing high school math and science teachers with hands-on research experiences in Army laboratories is admirable, and clearly, creating these linkages should familiarize the teachers with Army research, military science career opportunities, and the array of programs the Army offers to high school and college students. However, the program is not currently being managed with those goals in mind.

HSSMFP provides a fast and simple contracting process to allow researchers to sponsor teachers, and it would be very beneficial to offer these research experiences to teachers supporting AEOP programs, such as GEMS, MWM and SEAP. Those programs rely heavily on engaged teachers for success, and offering teachers participating in those programs the opportunity for meaningful laboratory experiences as part of that collaboration would be highly beneficial.

However, because Army researchers pay for the teachers they sponsor from their own project budgets (plus a 6% processing fee to ARO), additional funding would be required to accomplish this goal. Given that AEOP programs are already run on a shoestring, creating research experiences for teachers who support AEOP cannot be a top priority at this time. Should adequate resources become available, the Army should use the HSSMFP authority to create meaningful research opportunities for teachers who support AEOP-branded programs.

Appendix III: National STEM Education Programs

Professional Associations

- ***Society of American Military Engineers*** - www.same.org

Alexandria, VA

Purpose: To be a premier global engineering organization leading the professional and personal growth of all members in support of military readiness and development of solutions to national security challenges."

STEM Education: Education and mentoring fund to promote educational, professional development, and mentoring goals; maintains student chapters and a student council; local posts mentor and build relationships between SAME members and students majoring in engineering; annual awards to recognize student leaders; operates three summer camps (CO, CA, MS); supports national Mathcounts competition; supports several scholarships; and promotes engineering career awareness.

Association for Women in Science - www.awis.org

Washington, DC

Purpose: Promote equity and full participation for women in science, mathematics, engineering and technology.

STEM Education: Scholarship program. AWIS chapters and individual members involved in one-on-one mentoring, school lectures, career days, school visits, and teacher workshops.

- ***National Society of Black Engineers*** - www.nsbe.org

Alexandria, VA

*Charneta Samms from ARL is on the National Executive Board

Purpose: Its mission is to increase the number of Black engineers, through developing student interest in engineering, increasing the number of minority students in undergraduate and graduate-level engineering, and providing career advice. Maintains 270 chapters on college and university campuses, and 75 pre-college chapters.

STEM Education: Pre-college initiative involves tutoring and SAT/ACT prep, tours of college campuses and engineering corporations, scholarships, science and engineering projects, and involvement in FIRST Robotics and Mathcounts. NSBE Jr. members participate in seminars and workshops, get free materials on college admission and engineering careers, and are offered competitions on scientific design, oratory, and essay. NSBE offers several scholarships. Has active partnerships with about a dozen organizations.

Some of NSBE's present activities include: tutorial programs, group study sessions, high school/junior high outreach programs, technical seminars and workshops, a national communications network (NSBENET), two national magazines (NSBE Magazine and the NSBE

Bridge), a professional newsletter (The Career Engineer), resume books, career fairs, awards, banquets, and an annual national convention.

American Society of Mechanical Engineers –www.asme.org
New York, NY; Washington, DC Center (202-785-3756)

120,000-member professional organization focused on technical, educational, and research issues.
Purpose: Promote and enhance the technical competency and professional well being of members, and through quality programs and activities in mechanical engineering, better enable its practitioners to contribute to the well being of humankind. Promotes the benefits of engineering education.

STEM Education: Education efforts include workshops, teaching materials and partnership opportunities to help teachers and engineers strengthen the math, science, engineering, and technology skills of young people, as well as to assist them in becoming more aware of the role of engineering in their lives.
Works with universities to develop pre-college engineering education plans, offers on-line lesson plans and activities for classroom use, provides career information, and encourages ASME sections to present workshops for middle school STEM teachers. Has a partnership with the Boy Scouts of American to promote technological literacy, and a partnership with the Girl Scouts to promote STEM and STEM careers to girls. Involved with several contests and competitions.

- ***Minority Scientists Network -***
  http://sciencecareers.sciencemag.org/career_development/miscinet

Washington, DC

Purpose: Sponsored by the American Association for the Advancement of Science; provides a range of resources for minority scientists.

STEM Education: For students, information on science education, persisting in science studies, and career information and counseling is available. The network also provides advice for mentors, and best practices and other information for administrators. Sponsors a jobs bank. Provides news and profiles of minority scientists.

American Indian Science and Engineering Society - www.aises.org
Albuquerque, NM

Purpose: AISES is focused on increasing the representation of American Indian and Alaskan Natives in engineering, science, and other related technology disciplines.

STEM Education: At the K-12 level, sponsors: the National American Indian Science and Engineer Fair, which awards cash prizes and scholarships, as well as some teacher development. K-12 affiliated chapter programs are open to schools with American Indian students and offer opportunities for outreach programs, workshops, and summer programs. Holds national

conference annually, and regional conferences. Has 160 college chapters nationwide. At the post-secondary level, AISES administers five scholarships and a 10-week summer internship program that places students in Federal agencies. No DOD agency participates in the internship program. This year, sponsored 8-10 week internships at universities to increase American Indian students pursuing post-secondary/graduate-level education and careers in computing disciplines.

Society of Professional Hispanic Engineers - www.shpe.org
Los Angeles, CA

Purpose: Founded to provide role models for the Hispanic community. Works to enhance and achieve the potential of Hispanics in engineering, math, and science.

STEM Education: Has 179 student chapters in the United States and Puerto Rico. Pre-college programs include: high-school chapters that provide scholarships, mentors and tutors; assistance with national and local science and engineering competitions, and summer camps; a pre-college symposium on education and careers in science and engineering; and Spanish language engineering comic books. At the undergraduate level, the organization has partnered with NASA and the Department of Energy on internships. For high-achieving students, the organization arranges tours to corporate, university, and government research facilities. Provides a scholarship award to graduate students and a seminar program on graduate student issues. Sponsors national and research conferences and career expos.

- ***Society of Mexican American Engineers and Scientists*** - www.maes-natl.org

Webster, TX

Purpose: To promote excellence in STEM while cultivating the value of cultural diversity by: motivating and mentoring students and professionals; assisting students in securing financial aid and employment opportunities; empowering students, parents, and professionals through educational MAES outreach programs; and stimulating successful partnerships with the community, government, and industry to provide tomorrow's leaders.

STEM Education: Has chapters at about three dozen colleges, clubs at five high schools, and 18 professional chapters. Sponsors a national conference and international symposium annually. Operates four programs: a graduate student network, which provides research opportunities, mentoring, opportunities for networking, and professional support; a K-12 outreach program involving MAES member role models and mentors; the "Science Extravaganza," a one-day hands-on academic enrichment workshops for middle and high-school students; and a scholarship program. Has a formal partnership with NIH.

- ***American Chemical Society*** - www.acs.org

Washington, DC

Purpose: Provides broad range of opportunities for peer interaction and career development. Membership organization of 158,000 members at all degree levels and in all fields of chemistry.

STEM Education: ACS provides programs to engage elementary, middle school, high school, college, and graduate students in chemistry experiences and mentoring. Competitions, summer work experiences, information directories, career education materials, and student clubs (both virtual and school-based) are designed to support students in their studies and assist them in making informed career choices.

Provides teacher resources such as activities guides, teacher training, and learning resources; sponsors a dedicated web site for kids (www.chemistry.org/kids); a operates a community-based science program—Kids & Chemistry—implemented locally by ACS members and local sections. An on-line Virtual Chemistry Club offers: information on chemistry in everyday objects and products, chemical mystery projects, career information, tips for science fair projects, ask-a-chemist, chemistry history, and chemistry experiments.

Offers extensive information on chemical careers geared to high-school aged students. ***ACS's project SEED is designed to encourage economically disadvantaged high school students to pursue careers in the chemical sciences. During the summer, students work in industrial, academic and Federal research laboratories doing hands-on research guided by a scientist-mentor.*** College scholarships are available for SEED students. At the undergraduate level, ACS sponsors: a student exchange; college scholarships for students underrepresented in science fields; and a wide range of support for students such as mentoring, networking, and information on co-ops, internships, and summer jobs.

Educators Organizations

❑ **K-12**

- ***National Science Teachers Association*** - www.nsta.org

Arlington, VA

Purpose: 55,000 members include science teachers, science supervisors, administrators, scientists, and business and industry representatives. Also, serves as the voice for excellence and innovation in science teaching and learning, curriculum and instruction, and assessment. Promotes interest and support for science education.

STEM Education: 18 district organizations.
Has three major initiative underway: Building a Presence for Science, focused on promoting high quality science-based teaching and learning, including a national electronic network for teachers; *SciLinks*, an effort to develop Internet links for science textbooks; and the NSTA Institute, an online professional development program for science teachers. Maintains Internet-based discussion board. Sponsors both national and regional conferences focused on science content, teaching strategy, and research; these include an "Exhibition of Science Education Materials." Administers several awards for teachers and students.

Publishes four magazines for K-12 and college science teachers (Science and Children, Science Scope, Science Teacher, College Science Teaching), as well as numerous science books, and

teaching and assessment guides. Recommends science educational materials, and provides some teacher science resources, including lesson plans.

Plays role in advising NASA on its education efforts. In addition to NASA, partners with numerous corporations and Federal science-oriented departments and agencies (NIST, DOC, NOAA, NSF, USDA, DoEd, Interior, DOT, EPA, and FDA), but not the Department of Defense or any service branch or agency.

- ***National Council of Teachers of Mathematics*** - www.nctm.org

Reston, VA

Purpose: Public voice of mathematics education, providing vision, leadership, and professional development to ensure high quality mathematics teaching and learning. This includes providing guidance and resources for mathematics curricula, serving as a political and public advocate, and bringing existing research into the classroom.

STEM Education: World's largest mathematics education organization, with 100,000 members and 250 affiliates in the United States and Canada. Has program of grants and awards. Sponsors annual national and regional conferences, which include exhibitions. Publishes five journals for mathematics teachers, as well as numerous books. Offers some teacher resources, lesson plans, and student activities.

❑ **Post-secondary**

- ***American Society for Engineering Education*** - www.asee.org

Washington, DC

Purpose: Further education in engineering and engineering technology by: promoting excellence in instruction, research, public service, and practice; exercising worldwide leadership; and fostering the technological education of society. 12,000 members include deans, department heads, faculty, and students, including 400 engineering and engineering technology colleges and affiliates.

STEM Education: Policy positions support: ethics education for engineers, equal opportunity and access to STEM learning/facilities for underrepresented groups, and teaching sustainable engineering. Sponsors annual conference, global colloquium on engineering education, annual workshop on K-12 engineering education, and meetings for 16 geographic sections and zones. Operates an Engineering K-12 Center (www.engineeringk12.org) to gather in one place the most effective engineering education resources available to the K-12 community. This includes: "Go-Engineering," a free e-newsletter sent to thousands of K-12 teachers to help them make math and science studies more exciting; career information; links to lesson plans; data base of K-12 outreach programs (mostly universities); initiative to identify best practices in science and math outreach programs; links to internship programs.

- ***MESA Engineering Program***

(individual programs at schools)

Purpose: The MESA program nurtures minority students for careers in math and science. MESA is carried out at the university-level and seeks to increase enrollment, retention, and scholarships for educationally disadvantaged students.

STEM Education: Originally developed as a partnership between an Oakland high school and UC Berkeley's School of Engineering, MESA has grown to over dozens of programs in 15 states. Some MESA programs have a presence in high schools and middle schools, community colleges, and Indian reservations. Program components may include: study center; academic, career, and financial aid advising; orientation courses; organized group study; fields trips; career development; summer enrichment programs; mentoring and tutoring; and help identifying summer work and part-time jobs.

Networks and Research Organizations

- ***American Association for the Advancement of Science*** www.aaas.org

Washington, DC.

Purpose: An international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association. This includes fostering education in science and technology for everyone, enhancing the science and technology workforce, and increasing public understanding of science and technology.

STEM Education: Takes positions on a wide range of STEM-related policy issues. Operates fellowship program; partners in numerous programs with schools, teachers and librarians; partners with higher education institutions; involved in several projects to increase the participation of groups underrepresented in the STEM workforce; and sponsors a project to advance STEM literacy. Also offers a range of educational materials that educators, parents, and others can use to improve STEM education. Has some focus on career development. Also, one of four sponsors of an NSF-funded Center for Curriculum Materials in Science to develop guidelines for methods and materials to teach STEM.

- ***National Alliance of State Science and Mathematics Coalitions***

Arlington, VA
www.nassmc.org

Purpose: Umbrella organization for state coalitions of business, education and public policy leaders united for the improvement of mathematics, science, and technology education for all students. NASSMC is a network of 37 state coalitions and serves as the national advocate for the member organizations.

STEM Education: Focused on supporting math and science education reform. Publishes briefings on important STEM education issues and sponsors national and state-level conferences. Partners with NASA, NSF, NSA, and the Department of Education, but no DOD organizations.

National Action Council for Minorities in Engineering
White Plains, NY
www.nacme.org

Purpose: Increase the representation of successful African American, American Indian, and Latino men and women in engineering and technology, math, and science-based careers. The NACME forms partnership with corporations, educational institutions, foundations and governmental bodies. NACME and its partners foster research-based changes in policies and practices that ensure equal opportunities for the preparation and participation of all Americans in science, engineering and technology.

STEM Education: Nation's largest private source of scholarships for minority women and men in engineering. Over 15 percent of all minority engineering graduates have received NACME scholarship support. Serves as a conduit for internships. Working to establish a pre-college program. Offers block grants of up to $100,000K to its 44 partner institutions to expand their minority engineering student populations. Offers interactive "Road-map to Engineering" web site.

Junior Engineering Technical Society (JETS)
Alexandria, VA
www.jets.org

Purpose: Increase awareness of and interest in engineering and technology-based careers.

STEM Education: Develops, collects, and disseminates information to schools and students on the opportunities and contributions of engineering and technology professionals. Offers hands-on engineering aptitude self-assessment and technical education for pre-college students. Currently, a partner in UNITE. Sponsors a JETS Teams Competition (14,000 high schools students) hosted by more than 100 universities; and a high-school level engineering design challenge focused on helping the disabled enter or advance in the workplace. Offers nearly 50 JETS challenges for students to solve for a monthly prize. Publishes JETS Pre-Engineering Times e-newsletter. Offers career information.

- ***National Geographic Society***

Washington, DC
www.nationalgeographic.com

Purpose: Promotes geographic knowledge and knowledge of Earth's natural resources.

STEM Education: Offers a wide array of STEM-related educational materials in numerous formats—web sites, magazines, books, pod-casts, photographs, music, television, and films. Publishes five magazines, two focused on youth. Maintains education and children's programming department, and school publishing division. Offers extensive resources and activities for kids, including extensive resources for completing homework assignments. For teachers, offers standards-based lessons plans, other resources and guides, professional

development, and online learning communities. A foundation offers grants to teachers, education institutions, and nonprofits. Sponsors EdNet, an online service offering news, information on professional development opportunities, on-line communities, e-newsletter, and information on grants.

American Society of Civil Engineers- Reston, VA- www.asce.org

Purpose: Leadership, advancing technology, and advocating lifelong learning and promoting the civil engineering profession.

STEM Education: Focuses on a large number of engineering fields of interest to the Army. Provides fun engineering activities, and education and career information for kids. Sponsors two competitions, one on future cities and one on bridge design. Offers K-12 teacher resources, including a summer institute program. Also sponsors a teaching workshop for college faculty. Offers extensive career guidance and information. Represents more than 137,000 members.

Girl Scouts of America: Girl GoTech *(New York, NY)* - www.girlsgotech.org

Purpose: Helps girls around the country learn more about math, science and technology with opportunities such as science camps, science kits, and hands-on activities.
STEM Education: Web-resource for promoting math, science, and technology and STEM careers to girls.