2006-844: POWER UP!: CREATING LEADERS FOR COMMUNITY COLLEGE & HIGH SCHOOL TECHNOLOGY/ENGINEERING

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The **Power Up!: Creating Leaders for Community College & High School Technology/Engineering** project is a professional development program for high school and community college educators.

The project is addressing five critical needs:

- Engaging community college students with creative and realistic problem-solving engineering activities.
- Developing programs at the high school level that will lead students to consider pursuing technical studies at college.
- Fostering partnerships between community college and high school faculty to smooth the transition from high school to college.
- Creating a cadre of leaders, including both high school and college teachers.
- Increasing awareness among high school guidance counselors, college faculty advisors, parents, and other stakeholders about the importance of technology and engineering programs for all students at the high school and college levels.

PowerUp! focuses primarily on one area of engineering/technology—education about energy and power technologies. At a national level, energy and power technologies are becoming increasingly important for society’s continued development and growth. Engineers and technicians are needed to manage and maintain the current sources and grids while simultaneously alternative sources need to be explored for the future.

The project is a collaboration between the Museum of Science, Boston; three community colleges in Massachusetts: Bunker Hill Community College, and North Shore Community College, Quinsigamond Community College; three industry partners: Keyspan Energy, Northern Power, and The Engineering Center; eight school districts; and consortia throughout the Massachusetts Tech Prep Network.

This paper will describe some of the activities that the PowerUp! project has engaged in to foster increased understanding of engineering and promote student transition from high school to community college and set the stage for future examination of student recruitment, retention and completion of two year degree programs in engineering and technology areas.
Engaging community college students with creative and realistic problem-solving engineering activities.

The PowerUP! project choose to address this issue by offering professional development opportunities for faculty. In year 1, the project established a leadership team of educators consisting of both high school and community college faculty. Two faculty members from each of the colleges joined teams from area high schools to explore hands on projects. These projects focused on the renewable energy field using power and energy concepts as the key academic topics. From the colleges a mix of academic, technical, and engineering staff participated.

In the year following the workshop seminar series, all of the college level instructors implemented at least one of the new lab ideas in their classroom. At Bunker Hill Community College, physics professors used a water wheel design challenge and wind blade design task to help teach fundamental physical concepts. Quinsigamond focused around batteries and fuel cells and integrated presentation skills into course work for the engineering students. Northern Essex Community College worked with a number of the motor designs to explore alternative power generation connected with the wind blade design. The high school teachers also worked on a variety of projects through out the year.

The leadership team re convened in the spring to plan regional seminar series to be hosted by each of the community colleges. The goal of these seminar series was to expand the number of teachers using contextual learning activities centered on the power and energy theme, to address theoretical topics. Each of the regions presented a slightly different training, though all offered the wind blade design and ‘reverse engineering’ challenge (from the Ford PAS program). An additional group of community college faculty from the three partner institutions as well as three new colleges joined the teams this summer. The high school teacher base also grew to include over 60 educators ranging in subject background from special education, to English, to mathematics. Presently, these instructors are trying out different labs in their classrooms or exploring new ones and will evaluate the effectiveness of the activity content this spring.

In addition to the individual classroom focus, the grant is supporting curriculum and course development at the three partner institutions. Northern Essex Community College is developing two new technology courses targeted at the medical technical area and a general intro to engineering to engage more students in the program. Bunker Hill Community College is establishing a new degree program for Engineering Science. As part of this, they are designing a new introduction to engineering course that is hands on and engaging. Quinsigamond Community College has an established engineering program, but has begun re-evaluating their program structure and embarking on a major initiative to open a state of the art technology center serving central Massachusetts.
• Developing programs at the high school level that will lead students to consider pursuing technical studies at college.

The PowerUP! project also works directly with high school curriculum and instructional practices to promote student preparation for the community college engineering and technology options. Through the summer seminar series, we have provided hands on lab materials to over sixty high school educators. In our key partner schools programs are being established that will be able to articulate to the college degree programs by the end of this project. To date the following high school programs are established:

**Tantasqua High School:** Strong machine tech, engineering design and engineering technology program offered at both the individual course level for all students and as an intensive vocational training program for interested students. Will be part of the Quinsigamond Community College articulation project this year to create pathways leading to the two-year degree options.

**Worcester Vocational High School:** Developed a course sequence option for engineering overlapping a number of other programs. Teacher has also developed integrated units introducing engineering for physics class. This school is also part of the team working with QCC to establish a stronger articulated relationship into the technical areas.

**Doherty High School in Worcester:** This high school has a strong engineering program where teachers are integrating some of the PowerUP lab materials into the related power and energy units. They will work with QCC this year to identify articulation options.

**Peabody High School:** Established new engineering course with thirty students enrolled this fall. Students designed and built a solar panel for thermal heating. The model will be used for presentations with lower grades and as a template for a larger project to put units on the roof. This course replaces a lower level physics course bringing course science levels up to a higher standard through out the program. In addition, the high school is working on articulation programs with Northern Essex Community College.

**Salem High School:** Established a new engineering sequence of courses. Their program has been successful in introducing females into the field with even enrollment of the genders in the introduction to engineering and digital electronics courses. The next step is articulating these courses to promote continued involvement in the engineering field by the females enrolled. Specialized programs for the women are in place. Salem is also involved in a unique program to introduce engineering materials into the early childhood program.

**Cambridge Rindge and Latin High School:** Has an established engineering program. The program is part of the team with Bunker Hill Community College to provide articulated pathways into the new engineering initiative.
Charlestown High School: Developed an engineering overview course as part of a sequence of courses focusing primarily on the information technology field. The course includes a number of the renewable energy labs as a way to introduce engineering design concepts. Charlestown has existing articulations and is going to expand this program to include one with BHCC in the IT area this spring.

A number of other high schools joined the program this year and are working to implement course and program options. They will work closely with the colleges to identify course content that will improve students ability to be successful at the post secondary level in the engineering and technical programs.

- Fostering partnerships between community college and high school faculty to smooth the transition from high school to college.

Each of the community colleges have developed articulation agreements with regional high schools in the technical field areas. As part of the PowerUP! project, teams of faculty and high school educators will examine these articulations to determine if they truly meet the transitionary needs of the students. This year, data will be gathered to evaluate the enrollment, retention and recruitment of students into these programs. In Massachusetts students must take the Accuplacer placement test before enrolling in mathematics or English courses. In Massachusetts the community colleges had over 50% of the student body enrolling in two or more remedial classes. There is an obvious disconnect between the expectations to graduate from high school and the skills and knowledge necessary to gain placement into the first college level course work. This specifically affects high technology and engineering programs that require upper mathematic courses in the first semester. The teams at each institution will examine this issue in partnership with the high schools. Recommendations for course content at high school level, prep courses for summer, and alternative teaching strategies will be discussed. Benchmark data will be examined to see exactly where students place when transitioning from the high school programs into the college arena.

- Creating a cadre of leaders, including both high school and college teachers.

The PowerUP! project stems completely around the partnerships and collaboration of high school and college personnel. This year, each of the teams are working specifically to create programs of study that don’t end at the senior year in high school, but present course sequencing right through a two year degree option. The programs of study will give the framework for discussions around specific academic preparation, student support systems and retention. The teams will also work together to address ‘marketing’ issues surrounding the technical and engineering programs especially in regard to minority and female student recruitment.
Increasing awareness among high school guidance counselors, college faculty advisors, parents, and other stakeholders about the importance of technology and engineering programs for all students at the high school and college levels.

PowerUP! ran two highly successful symposia for Guidance Counselors. These events provided guidance staff with an opportunity to talk directly with engineers representing over 10 fields of engineering, in small groups. The first event was hosted at the museum of science. Engineers and college representatives teamed up at stations set up through out the Museum of Science. The stations were strategically placed near or in exhibits that represented some element of their field of work. Guidance staff was able to talk with the professional and the college faculty about the field. Participants from both this seminar and a western Massachusetts symposium were asked to evaluate their level of understanding before and after participating in the event.

The first Guidance Counselor Symposium that focused on Engineering and Engineering Technology was offered on November 10, 2004. PowerUP! with additional funding from a private donor, sponsored a full-day event for guidance counselors at the Museum of Science focused on increasing awareness, understanding, and familiarity with engineering occupations and college options. The program involved a keynote address on the importance of a technically literate society, a presentation on females in engineering and an interactive activity where guidance counselors talked with over 50 engineers and technicians stationed throughout the museum exhibit halls. PowerUP! created a series of documents for this event that one describes in simple language what engineers and technicians in that field would do and the second outlines the various educational paths to pursue engineering and technology careers in different fields. Participants found these posters/documents extremely valuable and asked to have copies to use in their work. These documents can be viewed or downloaded at www.mos.org/powerup.

Any participant who attended either the first Guidance Symposium (in 2002) or the second in 2004 was invited to a follow-up event on March 15, 2005 at the Museum of Science. The March 15th guidance workshop was designed to provide more in-depth experiences for the guidance staff. It included a lab activity for the guidance staff and a specific session on practices for application in the school lead by a staff person from the Massachusetts Department of Education who spearheaded the Career Counseling Curriculum model for Massachusetts

The final guidance event during 2005 was an event held in Western Massachusetts to accomodate individuals in the central and western part of the state. The Wester Massachusetts Guidance Symposium for Engineering and Engineering Technology was held at Smith College on April 12, 2005. This symposium included aspects from both the guidance symposium and the follow-
up session. Participants were introduced to the various fields of engineering and also engaged in a laboratory activity

**Numbers Impacted:**

110 guidance counselors and staff participated in the full day symposiums for engineering and engineering technology outlining opportunities in education and careers with a focus on diversity and gender equity. Over 90 percent reported that their understanding of engineering changed as a result of this event. (Three events offered in total.)

65 Engineers and Technicians: participated in the guidance events. Follow up sessions have occurred with a subgroup to explore the development of training for engineers who wish to work with schools. The subgroup will meet in April 2005 to design the engineer training focusing on three levels: elementary, middle, and high school. The program would be offered in the fall of 2005 with placements occurring in schools in 2005-2006.

**Some of the guidance responses to what they learned at these symposiums:**

- I learned about the diff kinds of engineering fields available, which is exactly what I wanted to do. How to better inform student's of the engineering opportunities that avail them.

- Helpful stats. Regarding engineering career field potential, diversity of the field and academic/personal characteristics of successful engineers. Variety of career paths

- Facets of engineering community and how marketable engineering is going to be. I was amazed at Christine Cunningham's statistics

- How I can better recognize what students I work with would 'fit' in engineering career paths. Importance of exposing students to field of engineering.

- Most shocking to me, was that scholarships in engineering go begging; for many years we have imported engineering students creating a real gap for engineers US born, to work in defense and sensitive industries.

- I have a much better sense of skills and qualities necessary to be successful in engineering fields. I also have a broader understanding of the interdisciplinary opportunities evolved in an engineering project.

I learned how important it is to be an engineer in our society. How large the problem is.

The majority of participants experienced some level of change to their knowledge, understanding and/or comfort level, advising students to enter engineering fields. The biggest area of change noted by the participants involved feeling comfortable suggesting engineering and technical programs to students (56% expressed that this symposium had ‘greatly’ changed this for them). Ninety percent of the respondents reported that their knowledge about various fields of engineering moderately or greatly changed (44% moderate and 46% greatly). (see charts and details in addendum 1).

The experiences with the guidance events supported the importance of awareness and knowledge by other staff, community, and family who influence a student’s decisions to participate in a program or seek continued education in the field. As a result, the community colleges will continue to include guidance counselors in the regional sessions. They will play an active role in the design of the programs of study and identifying areas that supports for students would improve transition between the two institutional environments.

Summary:

PowerUp! is working to foster innovative teaching in faculty classrooms, introduce vital new subject areas and career paths to students, and educate a range of educational gatekeepers about engineering and the opportunities. The PowerUP! project is moving into the second phase, focusing attention directly on the connections between high schools and the three community colleges to provide clear and aligned programs of study in the engineering areas between the two institutions. As these programs of study are completed, we will be able to monitor the impact the program has on recruitment and retention in these field areas. One area of critical concern is the number of students needing to take remedial mathematic or English classes. Through these relationships, we hope to identify areas of student academic need, and provide strategies to address these needs.
Addendum 1: Guidance Counselor Symposia Evaluations:

Evaluation Results:
Massachusetts Guidance Symposium for Engineering and Engineering Technology
November 10, 2004
Museum of Science, Boston
Power UP! Initiative

Total number of responses: 52
Total number of attendees: 80 (80% of attendees were secondary guidance staff)

Part I: Participant answers based on changes felt as a result of participating in this symposium:

My knowledge of what engineers and technicians do:

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<th># of responses</th>
<th>% of total responses</th>
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<td>2%</td>
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<tr>
<td>Slightly</td>
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<td>21%</td>
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<td>Moderately</td>
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<tr>
<td>Greatly</td>
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<td>50%</td>
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My knowledge about the various fields of engineering and technology:

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<tr>
<td>Slightly</td>
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<tr>
<td>Moderately</td>
<td>23</td>
<td>44%</td>
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<tr>
<td>Greatly</td>
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<td>46%</td>
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My understanding about which types of students should consider engineering and technology careers:

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<th>Level of change</th>
<th># of Responses</th>
<th>% of total responses</th>
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<tr>
<td>Slightly</td>
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<tr>
<td>Moderately</td>
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<td>27%</td>
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<tr>
<td>Greatly</td>
<td>24</td>
<td>46%</td>
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My comfort suggesting students consider an engineering of technical program or career:

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<tr>
<th>Level of change</th>
<th># of Responses</th>
<th>% of total responses</th>
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<tbody>
<tr>
<td>Unchanged</td>
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<td>Slightly</td>
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<td>10%</td>
</tr>
<tr>
<td>Moderately</td>
<td>16</td>
<td>33%</td>
</tr>
<tr>
<td>Greatly</td>
<td>30</td>
<td>56%</td>
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</table>
The majority of participants experienced some level of change to their knowledge, understanding and/or comfort level, advising students to enter engineering fields. The biggest area of change noted by the participants involved feeling comfortable suggesting engineering and technical programs to students (56% expressed that this symposium had ‘greatly’ changed this for them). Ninety percent of the respondents reported that their knowledge about various fields of engineering moderately or greatly changed (44% moderate and 46% greatly).

**Part II: From a scale of 1 (not at all) to 10 (extremely) please rate how valuable you found each of the symposium sessions and the symposium as a whole:**

The average for all of the evaluations (52)

<table>
<thead>
<tr>
<th>Keynote Activity</th>
<th>Station Activity</th>
<th>Christine C/Ortiz</th>
<th>Group Activity</th>
<th>Closing Remarks</th>
<th>Over All Conference</th>
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<td>9.4</td>
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<td>7.9</td>
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Sixty two percent of the participants rated the opening keynote address a 10, and 77% of the participants rated the over all conference a 9 or 10. The group activity was the least effective of all the activities, however this still averaged close to an 8 out of the 1 to 10 scale. In reflection, this activity should have a specific task for the team to do, such as develop a marketing slogan or an ‘ad’ that could be presented to a chosen audience (student, parent, underclass, other educators, etc).

Overall, the conference was well received. The comments listed below accentuate the importance of the discussions and dialog that the participants had with the engineers, technicians and college representatives. It is evident that this experience truly influenced their understanding of the importance and diversity in the engineering and technical fields.

**Part III: Comments (edited from the full evaluation to reflect majority of comments):**

**What were the highlights of today’s symposium for you?**

- Was meeting the people behind the titles. That seemed so mysterious and complicated before.

- The (engineer and education) stations were very informative. I feel more comfortable talking to my students about the different careers in engineering. Networking. Number of engineers. Practicality of symposium

- Exposure to what engineering really is, so many diff. Directions and the importance of personal interpersonal skills. Awareness of different engineering careers. Keynote speech and importance of math/science being integrated into the technology course.

**What did you learn?**
I learned about the different kinds of engineering fields available, which is exactly what I wanted to do. How to better inform student's of the engineering opportunities that avail them.

how I can better recognize what students I work with would 'fit' in engineering career paths. Importance of exposing students to field of engineering.

I have a much better sense of skills and qualities necessary to be successful in engineering fields. I also have a broader understanding of the interdisciplinary opportunities evolved in an engineering project.


I learned how important it is to be an engineer in our society. How large the problem is.

How much more I need to know about the ignorance of society regarding the (engineering) field. The amount of opportunities for females and minorities

How important it is for the kids to have connections between classroom and the real world. The need to keep educating myself and my students in engineering opportunities.

Engineering is an extremely broad field. Importance of how engineering is marketed in terms of recruiting and retaining women in the field.

Very worth while no suggestions I ran out of time at the stations

a) Doing the hands-on activities helps me work with teachers, and important

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**Western Massachusetts Guidance Symposium for Engineering and Engineering Technology**

**April 12, 2005**

**Evaluation Results**

Over 60 individuals representing industry, post secondary, community and secondary education attended and participated in the event. Smith College hosted the symposium, which was funded by the National Science Foundation and Hunt Foundation as part of the PowerUP! initiative lead by the Museum of Science in partnership with the Massachusetts Tech Prep Network. The goal of
the event was to increase awareness and understanding of the multi-facetted options in the field of engineering and engineering technology. This report is based on written evaluations from the participants and the presenters.

Comment Section:

The following is a selection of the written comments from the participants in the Western Massachusetts Guidance Symposium for Engineering and Engineering Technology. The full list is available from the project manager (C.Shaw cshaw@mos.org). It is interested to note the high number of positive comments about the roundtable discussions presenting strong support to keep industry and education communication lines open.

A few people requested more female presenters. For industry, we had equal numbers of females to males. Where we didn’t have equal representation was from academia. All of the roundtable presenters representing post-secondary education were male (all faculty representatives) with the exception of Erin from NEIT (coordinator of high school programs). This leads to a question: what is the number of female faculty in engineering disciplines?

What were the highlights of today’s symposium for you?

- Hands on demonstrations, speaking with employers and faculty from the colleges.
- The roundtable discussions!! Civil and Biotech: I was amazed at the level of knowledge.
- Being exposed to resources that are available. Excellent speakers
- Thank you! This was great!
- Great presentations by the roundtable!! Great discussions
- Keynote speaker was wonderful. Each speaker was wonderfully passionate about their discipline and stressed the importance of communication skills.
- The wealth of information and its dissemination
- The mix of people from school, college and industry and the information gained from all their contributions. The commitment of the group as a whole to creating change.
- Presentation ‘Engineering for Everyone’
- Great idea (the symposium as a whole)
- Interaction with counselors who may have influence on individuals. (Presenter comment)
- An opportunity to discuss applicant skill requirements with guidance counselors. Learning about the issues related to getting women into the engineering profession. (Presenter comment)

What did you learn?
- Value of less technical skills, more humanities, communication and collaboration. Diverse fields, importance of hands on
- LOTS! Industry and college want/need to break stereotypes
- Number of fields of engineering and what engineering is really about!
- Gained a better understanding of what engineers do and became aware of all the supports out there.
- Math/science is only about half of what the day to day job is. Problem-solving and teamwork area slo very important along with communication and writing skills.
- How to encourage many more to enter this field.
- That engineering answers problems in all facets of modern life.
- Engineering is art! Engineering is the application of math and science to serve humanity.
- State and national efforts to improve participation in science and engineering for females as well as k-12.
- Poster information was helpful. I am already doing engineering at k-12 so a lot was already known but the networking and organization of the posters was helpful.

What other activities or events would you like to see offered?
- Teacher training, curriculum development
- Invite science and math teachers, also technology teachers in middle and high school.
- School-based programs like this for students. Plan to pilot this next year with the Tech Prep program.
- Lessons & ideas applicable to teaching. More women presenters
- More time to talk with each engineer.
- Great- more emphasis on careers – market trends- and interdisciplinary fields related to technology in different fields.

Industry/college presenter question: What should we do differently?
- Nothing
- Handouts-more of. More discussion on the display boards. Instructions on procedure
- Get more students to attend
- I really can’t think of anything – good job!
- Try to get everyone to each engineering roundtable
- More prep time for co-presenters
- Lengthen it. Discussions were brief.

Industry/college presenter question: Suggestions for collaboration around engineering and engineering technology?
- [www.engineers.org](http://www.engineers.org)
- Emphasize future challenges, related to energy, environment, sustainability and future job/career opportunities.
- Please make room for all levels of education. There are all kinds of jobs in engineering. I didn’t realize there was going to be such an emphases on women in tech.
- After-school programs with engineering societies.
- Any opportunity that you can present to the students to interview/talk with real engineers to help de-mystify thee career and to debunk the engineer stereotype.
- Set up some tours at industry for potential engineers from the high schools.

**Evaluation data:**

The first series of questions focused on the attitudes and comfort level of the participants related to the engineering and technology field areas. Rating levels; Remained unchanged, slightly increased, moderately increased or greatly increased.

- Over 75% the participants answered that their knowledge of what an engineer and technician does increased moderately or greatly as a result of this event.

- The majority of participants said that their knowledge of the various fields of engineering greatly increased. This could be a result of the number of applications that were presented by both the roundtable discussions and the keynote presentations.

- Participants reported that there was only a slight increase in their ability to determine the types of students that should consider the field areas. This could be a reflection on the design of the event; we specifically discussed diversifying and expanding the type of student who could be interested and successful in the field of engineering.

- The majority of participants said their comfort suggesting students consider the field of engineering ‘greatly increased’ as a result of this event. It is interesting to note that one counselor rated this question a ‘1’ but they commented that they were already very comfortable recommending that students consider engineering as a college/career option.

The second part of the evaluation had the participants rate components of the event on a scale of 1 – 10, 1 being ‘not at all’ and 10 ‘extremely’. Twenty-two participants rated this section.

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<th>Average</th>
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</table>
Both the Keynote: Engineering a Sustainable World and the Roundtable Discussions received 10’s from the majority of participants.

Reference/Bibliography


Teaching/guidance resources:

Re-Energy Canada, [www.re-energy.ca](http://www.re-energy.ca)
Kid wind, [www.kidwind.org](http://www.kidwind.org)
Engineering the Future, [www.mos.org/etf](http://www.mos.org/etf)
PowerUP!, [www.mos.org/powerup](http://www.mos.org/powerup)
IEEE, lesson plans for teachers and classroom outreach.