

# Building our Future through ASHRAE's Role in STEM Education

Members Council K-12 Science, Technology, Engineering and Mathematics (STEM) Ad  
Hoc Committee

Committee Roster:

  
Chair







  
Staff Liaison



June 22, 2008

## **I. Mission**

The Ad Hoc Committee was established by Bill Harrison as the chair of Members Council on May 24, 2007 to develop a position document outlining the importance of STEM education to ASHRAE, provide direction and guidance for an advocacy effort, formalize ASHRAE participation in K-12 related activities, and other related goals. The full list of charges given to the Ad Hoc committee can be found in the committee appointment letter contained in Appendix A.

Bill Harrison clarified the purpose of the committee in his email dated July 16, 2007 wherein he stated, in part:

*Ok, so we have about 35,000 members organized into about 145 chapters in North America. About 5,000 of these members do more than pay their dues. Your mission is to devise a method of inspiring those 5,000 members to change the way that parents and children look at STEM education so that we ultimately graduate more engineers and scientists from our colleges and universities. What can we do that might really influence parents and kids?*

Based upon the two documents referenced above, the Ad Hoc committee recommends that ASHRAE's STEM mission be as follows:

*“Inspire today's students to become the next generation of scientists, technologists, engineers and mathematicians.”*

Arising from the mission statement, the committee developed a recommended set of principles and goals for ASHRAE's STEM initiative. This document is contained in Appendix B of this report.

## **II. The Need for STEM Education**

ASHRAE's need to attract young men and women into the Society has been long discussed and well documented. The average ASHRAE member is nearly 55 years of age, one of the highest averages of any professional society in North America. Part of the problem is related to demographics that are having adverse affects globally. Using North America as an example, some of the more relevant statistics follow:

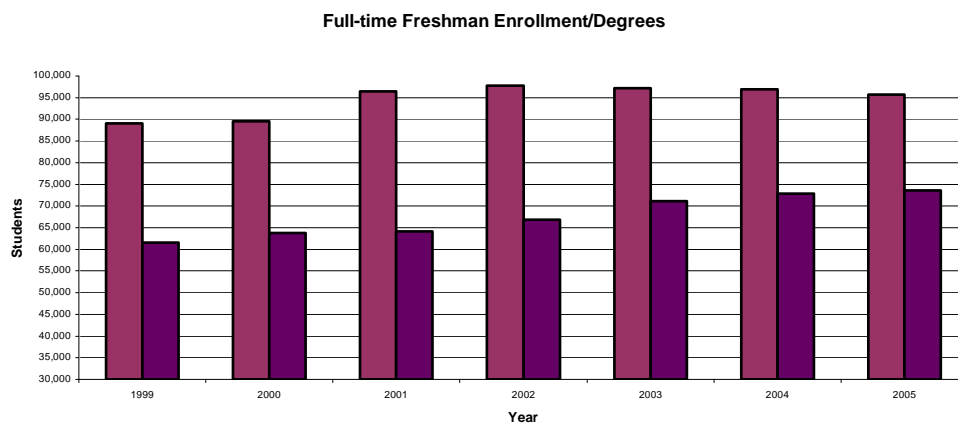
- In 2008, the oldest Baby Boomer (1946 to 1964), also known as Boomers, turns 62. This generation is immense, with approximately 80 million members in the United States<sup>1</sup>. As this generation begins to leave the workforce, it will create a void that must be filled by following generations.

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<sup>1</sup> U. S. Census Bureau

- Complicating the situation, the Boomers are retiring earlier than any other previous generation. Current data (Gendell, 2001) shows that the average age of retirement in the United States is now less than 62. Data for Canada<sup>22</sup> shows exactly the same trend.
- Generation X (1965-1983) is a very small generation with approximately 40 million members<sup>3</sup>. Accordingly, we will need all of Generation X and one-half of Generation Y just to replace the Boomers.
- The number of new engineers produced each year will be inadequate to replace the number of Baby Boomer engineers who will soon be retiring. The United States produces approximately 74,000 engineers a year (Grose, 2006), a number that has remained essentially flat for the past decade, as the following graph depicts. Approximately 2,000,000 people in the United States are currently listed as engineers according to the Bureau of Labor Statistics.

Figure 1.



Number of student enrolled in engineering (light bars) versus the number of students earning a Bachelor of Science degree in engineering, 1999 – 2005 (dark bars) (Grose, 2006)

- As our technologically based society continues to grow, the growth in engineering positions will continue to grow. For example, recent estimates by the American Institute of Architects indicate that by the year 2035 approximately 75% of all existing structures will be renovated in order to make the buildings economically viable from an energy efficiency standpoint. Moreover, it is estimated that

<sup>2</sup> Statistics Canada

<sup>3</sup> U. S. Census Bureau

approximately 23.8 million new households will be added by 2020 just to accommodate the changing demographics of the United States<sup>4</sup>.

- The need for STEM education is not limited to North America. The Financial Times in London (4/18, Turner) reports, "Almost half of companies across all sectors are having difficulty recruiting staff skilled in science subjects," and "more than nine in 10 employers [are] seeking STEM (science, technology, engineering and math) graduates," according to the first survey of Britain's skills by the Confederation of British Industry (CBI). The survey also found "a 15 percent fall in engineering and technology graduates over the past 10 years" in the U.K., and that employers were increasingly looking overseas "'to hire STEM graduates,' with more than one in three larger companies recruiting them from India, and a quarter from China."
- The New York Times (5/17, Fackler) also reported that Japan, "[a]fter years of fretting over coming shortages," is facing a dwindling number of young people entering engineering and technology-related fields." The phenomenon, called "rikei banare," or "flight from science," has become "so drastic that industry has begun advertising campaigns intended to make engineering look sexy and cool." According to the Times, Japanese "educators, executives and young Japanese themselves" say that "the young here are behaving more like Americans" and "choosing better-paying fields like finance and medicine. While "Japan has been scrambling to entice more of its younger citizens back into the sciences and engineering,...labor experts say the belated measures are limited and unlikely to fix the problem."

### III. Existing STEM Initiatives

Investigating current STEM initiatives, the committee has found a wealth of existing programs. Many of these programs are very well developed and have proven to be very successful. What is lacking in this environment is an overarching, coordinated vision to tie the programs together. What we have is a large number of well-intentioned, dedicated people with a passion for STEM education, each going their own way. Additionally, some of the concepts and skills important to a career in the HVAC&R fields are not adequately covered in these existing programs.

Some of the more impressive STEM initiatives are as follows:

1. Part game show, part reality TV, and part spoof, FETCH! features real kids, real challenges, real science, and a real host – Ruff Ruffman. The program shows the fun of learning, problem solving, and teamwork. FETCH! is produced by the WGBH Educational Foundation.



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<sup>4</sup> U.S. Housing and Urban Development

2. The American Society of Civil Engineers (ASCE) has several outstanding STEM programs already in place. In fact, ASCE seems to be well ahead of most professional societies in their STEM activities. A few notable examples follow:

- ASCE has joined Universal Studios and Scholastic Inc. in developing educational materials that introduce engineering design concepts to students in grades preK-1. One such endeavor is their publication featuring Curious George, who is bringing civil engineering to students in grades preK-1.



- The *Civil Engineering: It's Everywhere* Activity Guides for students in grades 3 and 8 offer kids a cool introduction to the world of civil engineering. Filled with fun factoids and challenges, these guides are designed to keep kids experimenting at home or in any educational setting.



- By bringing fun, hands-on math, science and engineering activities into classrooms, ASCE members can show kids fundamentals of the civil engineering profession. Beyond prompting students to become civil engineers in the future, these educational outreach programs support basic civil engineering knowledge that is necessary for citizens to make informed decisions on infrastructure issues in their community and the global world.

**West Point Bridge Design Contest**  
**bridgecontest.usma.edu**

- A five-part PBS series sponsored by ASCE, *Building Big* focuses on five major types of construction integral to modern life: bridges, domes, skyscrapers, dams and tunnels. This documentary explores the inner workings of large structures and the challenges faced by civil engineers who designed and constructed these landmarks throughout history.



3. The American Society of Engineering Education (ASEE) also has a number of excellent STEM initiatives including a new interactive website strictly promoting STEM education and resources available to students and educators (<http://www.engineeringk12.org/>). This interactive site includes:

- A free ASEE publication entitled 'Why K-12 Engineering?' that will help teachers introduce engineering into their K-12 classroom.
- A nationwide database of all colleges and universities that have outreach programs for K-12 students from which teachers can search to find programs that suit their needs.

- Annual Workshop on K-12 Engineering Education. This daylong event occurs in a different location each year and is designed to introduce 250 area teachers and engineering educators from across the country to innovative, effective engineering education resources designed for the K-12 classroom
- An ASEE publication entitled “Engineering: Go For It” that is designed for high school students.
- Links to [www.teachengineering.org](http://www.teachengineering.org): The *TeachEngineering* digital library provides teacher-tested, standards-based engineering content for K-12 teachers to use in science and math classrooms.

#### **IV. Demographics – Generation Y**

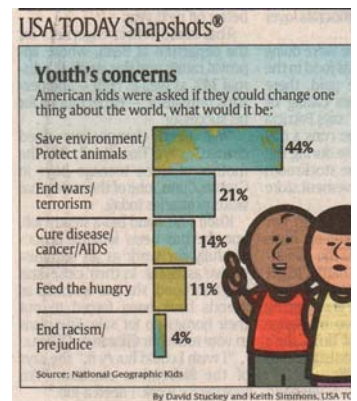
It is the committee’s position that ASHRAE would be best served by focusing its efforts on middle-school students (grades 6 through 8). We believe that a wide array of STEM initiatives already exist for students in grades K through 5. Moreover, we believe that ASHRAE’s efforts to differentiate its niche within the broad field of engineering would be more effective with students age 11 through 13.

Students of this particular age are at a crossroads where they have to make many decisions, some of which may impact their future careers. It is at this point in their lives that most young students have recognized the fact that they probably won’t become the next Tiger Woods or the next Hannah Montana, leading them to ask, for the first time, that all important question, what am I going to do with my life? This leads to another set of questions, which revolves around the set of math and science courses they will take. Contacting these impressionable young students at this critical junction of their lives may well produce a life-changing decision to consider engineering as a profession.

Middle-school students are a part of the vast millennial generation, also known as Generation Y (1984 – 2002). Numbering over 78 million, they are approximately the same size as the Baby Boomer generation, the largest single generation in the history of the United States. Due to the imminent retirement of the Boomers, Gen Y holds a particularly important role in society. It is the position of the committee that the general characteristics of Gen Y bode well for our industry overall and ASHRAE in particular. We also believe that by carefully structuring our initiatives to overlay Gen Y’s strengths ASHRAE can produce a more effective and timely response to the coming crisis.

Some of the principal characteristics of Gen Y that apply to our situation are as follows:

- Gen Y is more socially conscious and connected than any generation since the Greatest Generation, also known as the G. I. generation, (1908-1926). In a recent Business Week article<sup>5</sup> it was reported that 74% of Gen Ys' are more likely to pay attention to companies deeply committed to a cause, 69% consider a company's social commitment when deciding where to shop and 66% considered a company's social commitment when recommending products. Another survey, conducted by National Geographic for Kids, shows that changes in the environment is by far the number one priority of grade school children. The snapshot to the right, from USA Today, illustrates this point dramatically.



- Gen Y identifies with technology more than any other generation. Boomers, in contrast, are more likely to identify themselves with their job. In research conducted by Calvert (1999), 100% of Y respondents said that the “huge increase in information sources that has come with the development of the web has made no difference in their ability to sift out false information”. A statement such as this is simply inconceivable to a Boomer, as they do not have a personal identification with technology and, thus, are much less trusting of technology in general and the Internet specifically.
- Gen Y students love a fluid environment. Products with a shelf life of 3 months do not upset members of Gen Y. In fact, they expect it. The rate of technological advance in the United States has produced a very fluid environment, whether we like it or not. This type of environment is ideally suited for Gen Y.
- Gen Y students bond particularly well with their own generational members and are far more inclined to excel at team-based learning and collaborative projects. Approximately 60% of all Gen Y students have spent a significant amount of time in a single-parent family (Manuael, 2002). Moreover, most of those single parents found it necessary to work full time to support the family. As a result, Gen Y children bonded with other Gen Y children.
- Gen Y students are very brand sensitive. Interestingly, they are not very brand loyal. In the same Business Week article referenced previously<sup>6</sup>, 89% of Gen Y respondents stated that they are likely to switch brands to support a cause.

<sup>5</sup> Business Week, Nov. 6, 2006

<sup>6</sup> Business Week, Nov. 6, 2006

## **V. Recommendations**

Accordingly, the Ad Hoc Committee offers the following recommendations:

1. Relay the importance of member involvement in STEM related activities from the leadership of the Society.

ASHRAE leadership has significant influence over the activities and actions of individual members and chapters. The committee therefore recommends that leadership include in their presentations to members concerns about the future of the STEM workforce and the need to engage with students. Providing a challenge to the membership from the top down will help spur member involvement in STEM activities like those recommended below.

We also believe that an overall goal is necessary once the mission and vision has been accepted by Society. We are proposing a goal of reaching one million students by 2010. We believe this goal is aggressive, but attainable.

2. Tailor our message to fit Gen Y's deep and compelling belief in sustainability and the environment.

There is an overwhelming amount of data that shows Gen Y places environmental concerns at the top of their list of priorities. ASHRAE's commitment to sustainability and high-performance design and construction is second to none and would represent the perfect attraction to Gen Y, if properly packaged and marketed to the target age group. Some potential marketing strategies include:

- Updating the material on the Student Zone to be more timely and useful in STEM activities.
- Provide relevant activities, experiments and classroom material that reflects ASHRAE's mission on sustainability
- Provide "leave behind" materials that resonate with the target audience including a link to an exciting, interactive webpage
- Consider funding the development of working models in refrigeration, solar heating, etc. for the student branches to use in the classroom.

3. Energize the Society as a whole by launching the STEM program through ASHRAE's student branches.

We believe there is a lot of logic to initiating this program with student branches leading the membership as a whole. The student branches have the potential to be the perfect vehicle to deliver our message to younger members of Gen Y. Even though the student branch members are obviously older than our target audience, they are still members of Gen Y and will connect more easily to our target audience of 6 through 8 graders. This fits in nicely with one of the great strengths of Gen Y, their ability to bond closely with other Gen Y members.

Additionally, ASHRAE's student branches generally have not been connected to the activities of the rest of the Society. This proposed initiative helps to correct that situation by empowering the student branches with the responsibility for this critical task. Using ASHRAE's strategic vision on sustainability and high-performance buildings as a foundation for this initiative also will better connect our student branches to the mission and vision of our Society.

Currently, ASHRAE has over 200 active student branches, most located in major cities and towns. Assuming each middle school has at least 500 students, each student branch would only have to produce approximately 9 contacts throughout the academic year. This could be achieved by partnering with local ASHRAE chapters, involving YEA members, integrating pre-existing E-Week activities or other similar outreach activities. We believe that this is exactly the type of challenge that would resonate among Gen Y members. This also implies that Society would have to make available the resources necessary to enable the student branches to make these contacts.

Undoubtedly, for the first program, we would have to borrow extensively from other organizations with existing STEM programs to make this work. Over time, we could work with other organizations to modify the materials to be more specific to ASHRAE. Additionally, we might also want to consider workshops or training sessions at the ASHRAE winter meeting, where we have the greatest amount of students available. A separate student summit to address these issues also may be appropriate. Several organizations have very successful student summits during the school year to unveil student competitions, provide student leadership workshops and other related events.

4. Have both YEA and ASHRAE members serve as mentors to the Student Branches.

The student branches will need some guidance and resources in order to carry out this important mission. We also need a mechanism in place to extend the engagement up through the Society's members. At the same time, we must also consider the fact that currently only about 5,000 of our 50,000-person membership actually volunteer for ASHRAE initiatives. This proposal would put a minimal amount of stress on our active volunteer base. It is also imperative that we make the process of mentoring as easy as possible with a well-developed program. The YEA program within ASHRAE has been very active and we believe that the younger members found within YEA would serve as ideal mentors for this initiative. At the same time, many ASHRAE members have volunteered for similar STEM activities in the past and will no doubt do so again, if called upon. We certainly want to encourage anyone with a desire to interact with middle school students to become active in this program.

5. Implement an incentive program to inspire and motivate student branches to action.

Again, research shows that Gen Y is a highly motivated, goal-oriented generation. Accordingly, we recommend that a program be established that rewards student branches for excellence in the area of STEM educations. A few ideas follow:

- Encourage the use of technology such as the Internet, YouTube, FaceBook and other similar techniques.
- Provide monetary or Society awards for student branches that excel at STEM activities. This may include trips to the ASHRAE convention, ASHRAE materials, tee shirts, plaques or other similar motivators. Society should also encourage local chapters to issue grants to support the student chapter STEM activities.
- Implement an ‘Award of Excellence’ grant program that provides monetary funding to student branches that produce a particularly innovative or effective method of bringing STEM education to their local middle schools.
- Develop a ‘Student Branch of the Year’ competition that is heavily weighted to STEM programs

6. Develop a consortium of STEM organizations to take advantage of existing programs and initiatives.

As discussed previously, there is a wealth of STEM activities ongoing in a wide variety of organizations, such as ASCE, ASEE and ASME just to name a few. Because of the declining number of Boomers available and the reticence of Gen X and Gen Y to enter the applied sciences, every professional society is going to face the exact same problem. Moreover, as dues revenues decrease, each society will be faced with limited resources. As a result, it is imperative that time, effort and resources are not wasted “recreating the wheel”.

As stated previously, we do not believe that there currently exists an overarching “umbrella” organization to unite all of the various organizations that have STEM initiatives. As a result, it appears that there are a number of redundant programs that overlap by grade and activity. Therefore, we recommend that ASHRAE initiate the development of a consortium to embrace those related organizations (i.e., ASCE, ASME, ASEE and others) with STEM initiatives to produce a consistent set of programs that can be used by all. A related goal would be to eliminate overlap between programs to produce a greater efficiency in both funding and services provided. For example, ASEE already has an excellent program in place to provide curriculum to K-12 students on engineering. A good use of our resources would be to partner with ASEE to ensure that some of the lesson plans or in-class experiments revolve around high-performance buildings and the role of HVAC&R.

ASHRAE's future depends on bringing a new generation of engineers into our profession. The critical nature of the task in front of us can not be overemphasized. Because the coming shortage of engineers affects virtually every aspect of our environment, society and lifestyle it is important for ASHRAE to participate in a broad range of K-12 STEM programs for the greater good. At the same time, we believe that ASHRAE can generate the most impact internally by focusing its efforts on middle school students, age 11 through 13. Our recommendations reflect those dual goals.

The STEM Ad Hoc Committee appreciates the opportunity to serve ASHRAE in this capacity. We are looking forward to working with ASHRAE to establish our Society as a world-wide leader in STEM education.

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**ASHRAE**

*Technology for a Better Environment*

Appendix A

1791 Tullie Circle, NE • Atlanta, GA 30329-2305 USA • Tel 404.636.8400 • Fax 404.321.5478 • <http://www.ashrae.org>

**William A. Harrison**

*Society President Elect*

E-mail: [waharrison@trane.com](mailto:waharrison@trane.com)

**TO:** K-12 Science, Technology, Engineering and Mathematics (STEM) Ad Hoc Committee  
Timothy Wentz, Chair  
David Meredith, Vice Chair  
Kelley Cramm  
Chuck Curlin  
Ryan Colker

**FROM:** William A. Harrison *Wm. A. Harrison*  
2007-2008 Members Council Chair

**DATE:** May 24, 2007

**SUBJECT:** 2007-2008 STEM Ad Hoc Committee Appointment

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You have been recommended for appointment to the Members Council K-12 Science, Technology, Engineering and Mathematics (STEM) Ad Hoc Committee for the 2007-2008 ASHRAE Society year; therefore, it is my pleasure to appoint you. Currently, the STEM ad hoc committee will run during the 2007-2008 Society year, and you should be available to serve during that time. At the conclusion of the 2007-2008 Society year, reappointment to the STEM ad hoc committee may occur should this ad hoc committee continue; however, appointments will be the decision of the 2008-2009 Members Council Chair.

The STEM ad hoc committee's purpose is to:

1. Develop position document outlining importance of STEM Education to ASHRAE, its members, and society
2. Provide direction and guidance for advocacy effort (particularly given increasing concern regarding U.S. competitiveness)
3. Formalize ASHRAE participation in K-12 related activities
4. Encourage ASHRAE member participation in education related activities in their communities
5. Develop programs to train and support volunteers to promote ASHRAE positions on K-12 STEM education
6. Identify opportunities for ASHRAE to be a leader in STEM education (particularly relative to ASHRAE specific professions/skills)
  - a. Curriculum development
  - b. Increased participation in K-12 design competitions/science fairs

***American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.***

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AN INTERNATIONAL ORGANIZATION

7. Develop a long-range plan for our place in K-12 education, including what we can do now, what we will be doing in five years, etc.
8. Establish ASHRAE with other leading societies as a supporter and promoter of STEM policies and advancement in K-12 curricula nationwide
9. Promote and support diversity through policies and programs for K-12 STEM education
10. Advocacy committee (short-term, ultimately with direction from ad hoc committee)
  - a. Develop legislative brief
  - b. Comment and advocate on behalf of STEM Education
  - c. Continue involvement in STEM Education Coalition Activities:
    1. Shows large community of interest/amplifies message
    2. However, need presence beyond coalition to show our interest and importance of STEM education to our professions

The ad hoc committee reports to Members Council and is authorized to hold all meetings in conjunction with Society winter and annual meetings. Upon request and with appropriate justification, additional meetings may be authorized by the Members Council Chair.

Transportation expenses are reimbursable, if requested, in accordance with ASHRAE's transportation rules (copy attached). Also attached is information about the American Express Travel service offered through ASHRAE. This service allows you to charge the cost of your airline ticket directly to ASHRAE with no out-of-pocket expenses to you. Your ticket must be purchased within ASHRAE's transportation rules.

Please indicate your willingness to serve on this Members Council ad hoc committee by responding to Tarra Holman at [THolman@ashrae.org](mailto:THolman@ashrae.org) or 678-539-1212 **by Friday, June 1, 2007**.

Thank you for agreeing to serve on the STEM ad hoc committee. I look forward to hearing reports of the ad hoc committee's accomplishments during the Society year.

cc: Gordon Holness, Members Council Vice Chair  
Carolyn Kettering, Director of Member Services  
Tarra Holman, Staff Liaison



## ASHRAE'S STEM PRINCIPLES AND GOALS

### ***Mission:***

*Inspire today's students to become the next generation of scientists, technologists, engineers, and mathematicians*

### PRINCIPLES

- Strong fundamentals in science, technology, engineering and mathematics are critical to global competitiveness and the development of future engineers and scientists.
- The future of ASHRAE, our professions, and a safe, healthy and sustainable built environment depend on development of future generations of engineers, scientists, and technicians.

### GOALS

- Establish ASHRAE and its members as a resource for educators and policy makers interested in advancing STEM education both in the classroom and through government policies.
- Give teachers, guidance counselors, and school administrators the tools and knowledge necessary to adequately convey the importance of STEM fundamentals.
- Connect with students at all grade levels both within and outside the classroom to encourage interest in STEM related fields and at higher grades, HVAC&R engineering.
- Facilitate ASHRAE member participation locally and nationally on issues of importance to the development of a technologically literate workforce and a new cadre of engineers.

### ACTIONS

- Work with federal, state and local governments to ensure policies, curriculum standards, and resources are aimed at improving the teaching and learning of STEM concepts and critical thinking skills.
- Engage students and teachers on an ongoing basis to develop and implement age appropriate lesson plans, career days, projects, science fairs, and other activities designed to build STEM fundamentals and encourage students to enter the STEM fields.
- Encourage cooperation between university colleges of engineering and colleges of education to ensure future teachers (particularly science and math) have the necessary skills and knowledge to engage students in engineering concepts and problem solving methods.

- Collaborate with other engineering societies, industry groups, and other interested organizations to develop programs designed to raise interest in STEM and encourage pursuit of STEM related careers.
- Develop materials that can be used by ASHRAE members, teachers, administrators, parents, university admissions counselors and others to encourage learning of STEM concepts and pursuit of STEM careers.
- Develop themes (e.g., sustainability, global warming, technology, high-performance buildings, fluid or rapidly changing environments) that engage the current generation of students. Deliver these messages using student-friendly media.
- Demonstrate the importance of this issue to ASHRAE members and encourage participation
- Link ASHRAE related disciplines (e.g., high instances of asthma in a community may lead to interest in IAQ issues) to students' interest in social and global issues