
Explore Engineering: Rose-Hulman's Outreach to Middle and High School Students

Dale Long, Rose-Hulman Institute of Technology

Fred Berry, Rose-Hulman Institute of Technology

Abstract

Rose-Hulman Institute of Technology (RHIT) places a high priority on reaching out to the local community. This is part of the formula for its success. Such outreach fosters service opportunities so students can discover engineering, mathematics, and science careers are about more than calculations, theories and books. Service is a fundamental aspect of being a professional and thus fundamental to our students' education. Pedagogically, learning in the affective and social domains is enhanced by such activities, helping improve cognitive learning. Although our emphasis on outreach is a top-down initiative, newcomers to the RHIT community have always been surprised by how unselfishly the staff, students and faculty rally to be a part of community outreach.

Terre Haute, Indiana, the home city of Rose-Hulman, is also a regional center for most of the Wabash River valley in west-central Indiana and east-central Illinois. Much of RHIT's outreach is to Wabash Valley residents. RHIT's EXPLORE ENGINEERING program strives to attract Wabash Valley middle and high school students into the fields of science and engineering. This program is offered every other Tuesday night during the academic year for 1-1/2 hours. Though the program was free for a number of years, a nominal fee of \$10 per family is now charged to join for the entire year. Over its nearly 15-year life, hundreds of middle and high school students have explored the exciting world of engineering and science thanks to their participation in EXPLORE ENGINEERING. The program has grown in popularity and stature during the past five years, thanks to the support of the Lilly Endowment Inc. and Indiana Space Grant Consortium. Prior to the recent funding, however, the program was still successful, though operating on little to no budget, other than the commitment of Rose-Hulman's Office of Communications & Marketing staff to organize and moderate the meetings every other week, publish a newsletter, maintain membership information and lead the faculty/staff mentoring team administering the program.

Key Words

K-12 Outreach

Explore Engineering: Rose-Hulman's Outreach to Middle and High School Students

Dale Long, Rose-Hulman Institute of Technology

Fred Berry, Rose-Hulman Institute of Technology

Introduction

Rose-Hulman Institute of Technology (RHIT) places a high priority on reaching out to the local community. This is part of the formula for its success. Such outreach fosters service opportunities so students can discover engineering, mathematics, and science careers are about more than calculations, theories and books. Service is a fundamental aspect of being a professional and thus fundamental to our students' education. Pedagogically, learning in the affective and social domains is enhanced by such activities, helping improve cognitive learning. Although our emphasis on outreach is a top-down initiative, newcomers to the RHIT community have always been surprised by how unselfishly the staff, students and faculty rally to be a part of community outreach.

Terre Haute, Indiana, the home city of Rose-Hulman, is also a regional center for most of the Wabash River valley in west-central Indiana and east-central Illinois. Much of RHIT's outreach is to Wabash Valley residents. RHIT's EXPLORE ENGINEERING program strives to attract Wabash Valley middle and high school students into the fields of science and engineering. This program is offered every other Tuesday night during the academic year for 1-1/2 hours. Though the program was free for a number of years, a nominal fee of \$10 per family is now charged to join for the entire year. Over its nearly 15-year life, hundreds of middle and high school students have explored the exciting world of engineering and science thanks to their participation in EXPLORE ENGINEERING. The program has grown in popularity and stature during the past five years, thanks to the support of the Lilly Endowment Inc. and Indiana Space Grant Consortium. Prior to the recent funding, however, the program was still successful, though operating on little to no budget, other than the commitment of Rose-Hulman's Office of Communications & Marketing staff to organize and moderate the meetings every other week, publish a newsletter, maintain membership information and lead the faculty/staff mentoring team administering the program.

Educational Benefits

Hands-On Learning Models: The students work in teams to complete hands-on projects to learn elementary engineering and science principles. Examples include mousetrap-powered cars, where elements of force, aerodynamics and simplicity of design were crucial to developing a successful project; construction of hot air balloons, where the students' efforts must consider heat transfer, aeronautics and teamwork; and constructing model bridges, where students learned project planning, cost effectiveness and computer techniques to build sturdy bridges.

Learning That Science and Engineering Are Fun Career Fields: The EXPLORE ENGINEERING program addresses national studies showing that teenagers lose interest in engineering, science and mathematics during middle school years. Students turn out in large numbers every year for the Edible Engineering Contest (constructing vehicles from simple food products), K'Nex® Building Projects (miniature roller coaster) and model rockets program. High school-aged

Explorers also participate in the National Engineers Week's RHIT Student Visitation Day program, a job-shadowing opportunity showcasing professional engineers and scientists.

Breaking Down Barriers: Students of all ages, ethnic and economic backgrounds, and academic skill levels come together twice each month to meet and exchange ideas on how to solve an engineering or science problem. They also learn that there are students in other areas of the community that are interested in becoming engineers, scientists or mathematicians.

Inside The Numbers: EXPLORE ENGINEERING Covers All Ages

To market the program and provide program visibility, information about EXPLORE ENGINEERING is distributed to counselors, math and science teachers and principals at Wabash Valley middle schools and high schools. Media coverage about the program is made available to the public through The Terre Haute Tribune-Star (daily newspaper, 44,000 circulation), The Brazil Times (daily newspaper, 6,800 circulation), The Clinton Clintonian (daily newspaper, 4,200 circulation), The Park County Sentinel (weekly newspaper, 800 circulation); WTHI-TV (Terre Haute's CBS affiliate); WTWO-TV (Terre Haute's NBC affiliate); and WSDM-FM/AM (Terre Haute's news talk radio station).

Students are also attracted to the program through recommendations by other Explorers or their parents. A total of 133 students from 25 area schools and home-school educational situations have been enrolled in EXPLORE ENGINEERING during the 2007-2008 school year, with an average of 75 students actively involved in the bi-weekly programs on the Rose-Hulman campus. Students come all the way from Indianapolis, one hour east of Terre Haute, to attend programs.

A demographic breakdown of the Explore Engineering roster reveals:

- 111 (83.4%) were middle school students
 - 27 in the sixth grade, 35 in the seventh grade, and 49 students in the eighth grade
- 23 (16.6%) were high school students
 - 7 freshman, 8 sophomores, 4 juniors and 4 seniors
- 88 were male students, with 45 female students
 - a high attendance rate by female students as compared to male students resulted in about 40% female student participation in the regular activities
- Eight counties were represented
 - Vigo, Clay, Vermillion, Sullivan, Parke, Greene, Marion (Indianapolis), Morgan (central Indiana) and Clark, Illinois
- 19 students were home-schooled

Explore Engineering Leadership

A two-member executive committee that included members of Rose-Hulman Institute of Technology's faculty and staff supervised the EXPLORE ENGINEERING program in 2007-08. These co-directors were:

RHIT's Director of News Services: This member of the college's Communications & Marketing staff serves as the primarily contact person for interested students and parents. He also plans

most of the educational programs, purchases supplies and publishes a bi-weekly newsletter that describes upcoming programs.

Chair of Electrical and Computer Engineering Department: This faculty member assists in many of the design projects and helps provide financial assistance through the Indiana Space Grant Consortium.

EXPLORE ENGINEERING also involves planning and facilitation of the actual activities by students and student organizations. In 2007-08, the following student groups and faculty assisted with EXPLORE ENGINEERING programs: The Cecil T. Lobo American Society of Civil Engineers Student Chapter; a chemistry professor; two computer science and software engineering professors; Alpha Tau Omega fraternity; the American Society of Mechanical Engineers Student Chapter; Alpha Chi Sigma Chemical Honor Society; Circle K and Alpha Phi Omega Service Fraternities; Institute of Electrical and Electronic Engineers; and Office of Student Affairs' Sophomore Advisors staff members.

Descriptions Of EXPLORE ENGINEERING Programs

The annual planning of EXPLORING ENGINEERING occurs in the summer before academic year startup. With the exception of the most popular programs, most EXPLORE ENGINEERING activities change every other year so that students can plan at least a two-year program involvement without seeing a lot of the duplicate activities. The 2007-08 schedule is typical of each year's activities. Starting in September 2007, EXPLORE ENGINEERING educational programs were conducted twice monthly through April 2008. These programs were:

Edible Engineering Contest: Student teams used edible objects (Oreo cookies, pretzels, Cheese Whiz and peanut butter) to build a movable object. This is a great program to start the year, showing the students that science and engineering are fun, and that they will have fun by participating in the program. The competition also attracts considerable media attention, further spreading important messages about engineering education and the program.

Scientifically Speaking: EXPLORE ENGINEERING lives up to its name as students get a chance to explore different types of science and engineering fields. These programs included:

- *Learning About Chemistry:* Students found out the chemistry properties of slime, Silly Putty and other chemical components.
- *Python Programming:* Students learned about Python computer programming to create beautiful computer-generated graphics.
- *Electrical Circuits:* Students built electronic circuits, created speakers and studied sound waves in the electrical engineering laboratories.
- *Night Under The Stars:* Students spent a night at Rose-Hulman's Oakley Observatory, using telescopes to examine astronomical objects and capture images with CCD cameras.

K'Nex® Projects: Students used more than 12,000 K'Nex® building parts to create ferris wheels, a carousel and roller coasters - creating a miniature amusement park that was put on public display in Rose-Hulman's Student Union building for four days.

Popsicle Bridge Competition: The Cecil T. Lobo ASCE Student Chapter organized a popsicle bridge design and construction competition. Each team of Explorers was provided a specific collection of popsicle sticks and assigned the task of constructing a bridge to support weight while spanning 22 inches and providing clearance for passage of a 2 inch x 4 inch cross section “barge” under the bridge.

Mousetrap-Powered Vehicles: Teams came up with an assortment of ideas when asked to design a vehicle that could utilize the power of a mousetrap to travel 15 feet. A car kit came with performance tips, wood for a frame, brass tubing for axles, compact discs for wheels and, of course, a mousetrap.

Egg Drop Contest: Teams of Explorers created a device to keep an egg intact when dropped from a height. Students were given an assortment of packing materials for their “egg capsule”. All projects were first dropped from a height of 15 feet. If successful, the project advanced to 30- and 45-foot distances.

College Information Night: Parents received advice on how best to prepare their children for college during an information session with a member of Rose-Hulman's Admissions Office staff.

Gear Head Night: Explorers and parents had the opportunity to visit five Rose-Hulman student design projects, learning first-hand the challenges of designing large-scale projects for national engineering competitions. The projects included the Challenge X hybrid sport utility vehicle, supermileage vehicle, Robotics Team, Aeronautics Club’s Design-Build-Fly project and Team Rose Motorsports.

Sail Away Design Projects: Teams tested their design and problem-solving skills to produce a lightweight vehicle that utilized sailing techniques to move down a track through wind power. This was a new project, developed by a Rose-Hulman student.

Robotics Projects: Students had the choice to create one of two electronic robots from kits: A Handy Gardening Robot, which used sensors to pick up objects (weeds) from a makeshift garden; and a Lady Bug Robot, which had six legs and made use of infrared emitting diodes as its eyes to avoid obstacles along its path. These projects were organized by a Mechanical Engineering professor and members of the Institute of Electrical and Electronic Engineers.

Bottle Rockets: Students experienced aerospace engineering and flight by designing and constructing their own bottle rockets. Rockets will be launched later this month.

Hot Air Balloons: Using different colored sheets of crepe paper, Explorer teams will create colorful, 6-foot-tall hot air balloons in the final project of the year. The balloons will be launched into the air later this month. This has become a favorite annual activity with the students and parents.

Additional Educational Activities During 2007-2008

Besides the bi-weekly educational programs, the EXPLORE ENGINEERING organized the following activities to involve youths in lifelong learning opportunities:

- JETS' (Junior Engineering Technical Society) TEAMS Competition: A team of eight high school EXPLORE ENGINEERING students tested their problem-solving skills against other area students in the 2008 TEAMS academic competition, conducted by the Junior Engineering Technical Society. Sixteen teams from nine Wabash Valley high schools participated in the March competition.
- Wabash Valley MATHCOUNTS (National Society of Professional Engineers): EXPLORE ENGINEERING advisers helped organize the annual regional MATHCOUNTS competition, a mathematical problem-solving contest for more than 200 area middle school students in grades six, seven and eight. EXPLORE ENGINEERING members did very well in this year's competition, posting three of the top 13 scores and advancing to the Indiana MATHCOUNTS competition.

Types Of Materials Purchased And Used

Funding from the Lilly Endowment Inc. and Indiana Space Grant Consortium was used to purchase the following educational supplies and projects:

- Lady Bug Robotics Project Kits (\$350)
- Bottle Rocket Construction Kits (\$275)
- Sail Away Design Project Kits (\$150)
- Hot Air Balloon Construction Supplies (\$50)
- Mousetrap Car Construction Kits (\$603)

Sponsorship also helped cover the postage expenses of the EXPLORE ENGINEERING newsletter, published bi-weekly, incurred by Rose-Hulman's Communications & Marketing Office (\$500).

Program Assessment: High Marks From Explorers & Parents

At the end of each year, the EXPLORE ENGINEERING staff surveys students and parents about the educational program.

Student Feedback: When asked to give an overall assessment of the EXPLORE ENGINEERING program in 2006-2007, three out of every five students surveyed gave the program "good" reports, with the remaining two viewing the program as "excellent." There were no unsatisfactory reports. The most popular programs were Chemistry Night, Edible Engineering, K'Nex® building projects and mousetrap-powered cars. To assist with planning for 2007-2008, the students requested more projects in robotics, egg drops, and K'Nex® building projects – all areas reflected in the 2007-08 programming. Students also expressed frustration in the amount of time available to complete projects, normally 90 minutes (7-8:30 p.m.). Overall, student opinions included the following statements:

- "We got to engineer lots of different things. It was better than school."
- "It is fun and interesting. You meet a lot of people."
- "It was very fun!"
- "It's cool!"

Parent Feedback: Three out of five parents surveyed assessed EXPLORE ENGINEERING as "outstanding," with the remaining two viewing the program as "good." There was not an overwhelming favorite or least popular program (one vote for 10 different programs). The hands-on experiences were viewed as the best aspect of the program. Parents found EXPLORE ENGINEERING newsletter to be very informative (all respondents) and felt that it arrived as households in time to prepare for upcoming events. Overall, parent opinions included the following statements:

- "Best organized program we've ever participated in over the past seven years in Terre Haute."
- "Very well organized and extremely stimulating. My child was encouraged to participate and it was OK if she couldn't work on a project."
- "It exposes students to various aspects of engineering, team building and socialization. Students make friends from other schools."

Program Leader Reflection: The program is a highly satisfying outreach to the community. Each leader can recall numerous examples of unsolicited parent feedback thanking RHIT and EXPLORE ENGINEERING's leaders for continuing the program. Although stepping into the program as a co-advisor involves climbing a learning curve to get into the flow of bi-weekly meetings, program leaders quickly gain confidence in the Explorers, RHIT student volunteers, and their own ability to make last-minute adjustments, when necessary, to assure a productive learning experience. There is also great satisfaction in seeing current and former Explorers succeeding regionally and nationally in science, engineering, and mathematics opportunities. Seeing our "graduates" pursuing careers in engineering is particularly satisfying. Students from the program have continued into engineering in college and are attending schools such as Massachusetts Institute of Technology, Harvard, University of Illinois, Purdue, IUPUI, University of Evansville, Tri-State University, and, of course, Rose-Hulman.

Summary and Conclusions

EXPLORE ENGINEERING has taken great strides during the past 10 years, increasing in student participation (from a membership of 54 in 1998 to 133 in 2007-08), demographics (more middle school-aged students) and diversity (more female and minority students). Also, funding from the Lilly Endowment, Inc. and the Indiana Space Grant provided the financial resources to improve the quality of educational programs - from simple "hobby shop"-type projects using spare parts from Rose-Hulman department laboratories to challenging projects, like mousetrap-powered cars, hot air balloons and K'Nex® building projects. The student and parent surveys from the past three years reveals that the EXPLORE ENGINEERING program has successfully achieved its goals of attracting and retaining area teenagers in engineering and science fields, while showing that these areas are fun and exciting.

Interested faculty or staff members at other schools are encouraged to contact any of the authors about the program to receive insights about starting a similar outreach initiative in their region.

DALE LONG is the Director of News Services with the Office of Communications and Marketing at Rose-Hulman. He has been the leader of the EXPLORE ENGINEERING team for 15 years.

FRED BERRY is a Professor and Chair of the Electrical and Computer Engineering Department. He has been a co-advisor for EXPLORE ENGINEERING since 1997.