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science IMPACT

CARNEGIE SCIENCE CENTER

At Carnegie Science Center's Dream Big Girls Night Out Engineering Challenge, girls employ engineering skills to tackle design challenges.

Science of Engineering Takes Center Stage at Carnegie Science Center

From a Design Challenge to Construction Work, Engineering is in the Spotlight

Every scientist was once a curious kid.

Today's engineers no doubt once stacked blocks, built chain reaction contraptions, and imagined cities of the future.

That's why recent initiatives at Carnegie Science Center prove that engineering is a natural – and fun – fit for inquisitive young minds.

Dream Big Girls Night Out

At the *Dream Big* Girls Night Out Design Challenge, held on opening weekend of the new Omnimax film *Dream Big*, 55 girls in grades 7 to 12 worked on three design challenges, after watching the film for inspiration. The new MacGillivray Freeman film spotlights the ways engineers are pushing the limits of ingenuity and innovation in unexpected, imaginative, and amazing ways. In its globe-trotting adventure highlighting engineering marvels around the world, the film also reveals the heart that drives engineers to create better lives for people worldwide.

Give a group of girls a little inspiration, a few rolls of masking tape, a ruler, a stack of paper, and a challenge – use these materials to build the tallest, strongest tower you can – and their imaginations will astonish even them.

Some built soaring towers, some built a house of cards capable of carrying 200 pennies. The toughest challenge was to engineer a wind-resistant tower able to withstand gusts from a fan. The event wove fun and friendly competition with the engineering design process.

Future City Competition

The Science Center's annual Future City Competition, held in January, challenges middle school students to build a tabletop scale model of their city of the future. This year's theme, The Power of Public Space, asked students to design innovative, multiuse public spaces that serve a city's diverse population.

The team from St. Bede School, a parochial school in the city's Point Breeze neighborhood, won the Pittsburgh competition and advanced to compete at the national competition in Washington D.C. during National Engineers Week.

The St. Bede team created Zumala, the City of Fellowship, located on the Nile River with a population of 300,000, in the year 3064. Their distinctive model included a front view of the city and a back view of its aquifers. Among the city's features are a plastic waste dump reclaimed by planting edible mushrooms that feed on plastic; plants to filter impurities from water; and a highway that was repurposed as a boardwalk for public recreation, including a theme park.

"We are tremendously impressed each year with the ingenious ways the students in the Future City Competition grapple with real-world issues and tackle engineering challenges – all in pursuit of making the world a better place," said **Linda Ortenzo**, director of STEM Programs at Carnegie Science Center.

Chain Reaction Contraption Contest

In December, the Science Center celebrated the work of several hundred high school students from across the region who participated in the 16th annual Chain Reaction Contraption Contest, an engineering competition. Five-hundred students in 44 teams from schools in Allegheny, Armstrong, Butler, Washington, and Westmoreland counties, and from Ohio, presented their contraptions to judges at this challenging and spirited engineering competition. This is the highest

(continued on page 3)

directors' note

Many of the articles in this edition of *Science Impact* showcase the various student programs, competitions, and teacher professional development opportunities Carnegie Science Center offers on engineering and the engineering design process. And frankly – even though as co-directors we get to experience all of these activities firsthand – it was fun for us to see the write-ups and photos and to reflect on the tremendous impact these programs have.

A quick story: We're Boomers, and we were talking to another Boomer colleague a few months ago, who told us she didn't even know what engineering was until she was well into high school. "Someone in my class mentioned that his dad was an engineer," she said. "I asked what railroad he worked for. Turns out the dad was a chemical engineer, which left me speechless. Back then, the only engineers I'd ever heard of were the guys in the funny hats on train engines!"

We all shared a good laugh, but there was poignancy to the story as well. How sad it was that young people in our generation weren't routinely exposed to the wide range of engineering careers they might pursue. (That was especially true for girls.) And what a shame that schools rarely taught the engineering design process – at least not in any but the more advanced high school courses.

Fast forward to today. We're inspiring even the earliest learners from pre-kindergarten through third grade with hands-on activities that teach them how engineers think. *(See article on page 3.)*

We're offering engineering-related competitions that unleash creativity and innovation and critical thinking in middle- and high-school kids. We're showing teachers how to incorporate these engineering lessons into their everyday classrooms so that their students can get pumped up about learning. And we're connecting real-world engineers in our region with students and teachers alike to encourage discussions about the really cool things engineers do in their careers.

Various research studies show that 75 percent of the fastest growing occupations across the globe are based in science and math, particularly some form of engineering. It's exciting to think that the kids we see in our programs today will step into those engineering careers and use their skills to make their world – our world – a better place to live.

Ron Baillie and **Ann Metzger**
Henry Buhl., Jr., Co-Directors

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Carnegie Science Center delights, educates, and inspires through interactive experiences in science and technology. By making science both relevant and fun, the Science Center's goal is to increase science literacy in the region and motivate young people to seek careers in STEM (science, technology, engineering, and math).

The Science Center also serves as a town square for community dialogue on science and its social implications and seeks to showcase regional science and technology advances.

One of the four Carnegie Museums of Pittsburgh, the Science Center is Pittsburgh's premier science exploration destination, reaching more than 700,000 people annually through its hands-on exhibits, camps, classes, and off-site education programs.

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Science Impact is available online at **CarnegieScienceCenter.org/Publications.**

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*Standing behind their fictional city built for Carnegie Science Center's Future City Competition, the winning team from St. Bede poses with their teacher **Betsy Killmeyer**, volunteer engineer mentor **Paul Lovejoy**, and David **Esquibel**, workforce initiative manager at Shell, who spoke to the students about what inspired him to become an engineer and why it's important for them to get a solid STEM education.*

Science of Engineering Takes Center Stage *(continued from cover)*

number of participating teams in the program's 16-year history. Participants worked for months to design, engineer, build, test, and re-test their contraptions. Each contraption was designed to accomplish a specific task of at least 20 steps within a two-minute time-frame. This year's contest task was to "Unlock and Lock It Up!" Greater Latrobe High School won first place for their "Lock" Ness Monster contraption. Our Lady of the Sacred Heart won second place; Hempfield Area High School won third place.

Engineer the Future

More than 5,000 people explored engineering at the annual "Engineer the Future event," which brought more than two dozen local companies and professional organizations to the Science Center for three days of engineering activities in February. Exhibitors offered hands-on activities, such as making superballs, building a boat capable of carrying as many pennies as possible, exploring how ultraviolet light works, and testing the weight-bearing limits of shallow versus deep foundations.

About 2,000 middle and high school students attended on field trips.

Helping Teachers Train Their School-Age Engineers

Engineering also has been the focus of teacher professional development workshops through Carnegie Science Center's new Teaching Excellence Academy.

In the Quadcopter Challenge educator workshop, teachers learn how to get middle- and high-school students excited about electronics, soldering, and the engineering design process by teaching them to make and fly their own palm-sized remote-controlled quadcopters. The immersive workshop explores step-by-step the process of designing, creating, testing, and redesigning quadcopters using a laser cutter or CNC router in the Science Center's Fab Lab digital fabrication lab.

Even for early learners, engineering is fundamental. The Science Center debuted a new teacher workshop this year titled "On a Roll: Engineering with Blocks and Ramps." The program offers guidance on incorporating engineering into early learner lessons. The workshop is designed to re-energize educators' use of the universal classroom blocks area, helping them to engage their students in the engineering process.

"Early learners are natural engineers," said **Wendy Brenneman**, Carnegie Science Center's manager of Early Childhood STEM Initiatives. "Young minds are inherently curious about stacking and building and rolling. Our new workshop builds on children's innate interest in tinkering and develops that curiosity into engineering skills."

An exciting engineering project has been on display all year as construction for the Science Center's Science Pavilion has begun. A wall was erected around the construction area, but two windows were placed on it to encourage visitors to see the construction work.

MICROBITS

Science on the Road Delivers Science across the Nation

A burst of air and a roll of toilet paper demonstrate Bernoulli's Principle – and elicit laughter –from the audience during a Science Center presentation called Science Takes Flight.

Carnegie Science Center's outreach program "Science on the Road" reaches more than 150,000 students each year in schools across southwestern Pennsylvania. Last year, with funds from PPG, Science on the Road traveled across the nation bringing dynamic science to 6,000 children in Alabama and California. *Science Takes Flight*, the newest Science on the Road assembly program, explores how innovative aircraft fly off the drawing board and into the sky and even features the fiery roar of propulsion chemistry.

Science Center Receives Gateway to Equity Award

***Linda Ortenzo**, director of STEM Programs – including Carnegie STEM Girls programs – accepted the award on the Science Center's behalf from AAUW representative **Jodean Brooks** (at left).*

The American Association of University Women (AAUW) Beaver Valley branch recognized Carnegie Science Center this spring with the Gateway to Equity Award. The award honors an individual or organization that promotes the AAUW mission of equity for women and girls through advocacy, education, philanthropy, and research. The Science Center has supported the Beaver Valley AAUW's annual Girls Recognition Nights for the past several years.

In the "Neuroscience, Physics, and Your Brain" workshop at Carnegie Science Center's SciTech Days, high schoolers experiment with a solenoid, a type of electromagnet used to generate a controlled magnetic field.

SciTech Days Program Spotlights STEM Careers

Workshops Showcase Pittsburgh's Growth Areas

SciTech Days, a twice-annual STEM-focused event at Carnegie Science Center, gives middle and high school students the opportunity to explore the growth areas of Pittsburgh, such as advanced materials, nanotechnology, robotics, biotechnology, information technology, and energy and the environment. Over the course of the four-day event in March, more than 4,000 people attended. Each semester, the first two days are geared to a middle school audience, and the second two days feature more rigorous programs for high schoolers.

> "SciTech Days are only a day each, but they **make a huge impact** on our school years."

Hands-on SciTech workshops provide students with a glimpse into cutting-edge STEM topics, such as bioengineering and neuroscience. At the neuroscience workshop, for example, students navigated the spectrum of the mind, exploring what scientists know about the brain and what they're still exploring. For an introduction to brain mapping and MRI technology, students experiment with a solenoid, a type of electromagnet used to generate a controlled magnetic field.

In addition to workshops, exhibitors from local companies and universities host hands-on booths at SciTech Days, showcasing their work and offering a first-hand look at STEM careers.

"We've been hosting SciTech Days for more than a decade, and as Pittsburgh grows as a hub for science and technology, the importance of SciTech Days has never been greater," said **Linda Ortenzo**, director of STEM programs. "SciTech Days give students hands-on experiences that bring classroom learning to life – and even new ideas for careers to explore after graduation."

Teachers laud the program, recognizing the excitement it ignites in their students.

"SciTech Days has been such a blessing to our school over the years," said **Joy Mattis**, a sixth-grade teacher at Moss Side Middle School in Monroeville, a suburb of Pittsburgh. "When we attended in the fall of 2015, the students loved the 3D printing workshop. [Then, we] were granted a 3D printer from our PTA and started a 3D printing program at our school. During Spring 2016 SciTech Days, students were extremely excited about the computer gaming workshop. We have since added Game Star Mechanics to our STEAM classes. During the last SciTech Days in the fall of 2016, the students became familiar with the Ozobots. You guessed it … We now own six Ozobots. The students are currently engineering a maze with ramps, tunnels, obstacles, and bridges and programming their Ozobots.

"SciTech Days are only a day each, but they make a huge impact on our school years."

At Carnegie Science Center's SciTech Days, students are encouraged to bring their own questions about cutting-edge scientific topics.

BOARD SPOTLIGHT

Pace Markowitz

Pace Markowitz believes STEM is for everybody.

That's why he has volunteered to participate in the Career Café workshop at Carnegie Science Center's SciTech Days over the past five years. And that's why being a Science Center Board member is so important to him.

"Personally and professionally, I'm passionate about all ages having the opportunity to experience science and hopefully pursue STEM-based careers. The Science Center is an amazing vehicle to show science in action through hands-on interactions that demonstrate that everybody can do science," Markowitz said. "Everybody can learn STEM."

Markowitz himself has explored several STEM careers at NOVA Chemicals. Now working on capital investments as Venture Leader there, he previously served as a process engineer, production supervisor, and communications director, among other roles. NOVA Chemicals has long supported the Science Center and is a founding partner of the Science Center's Chevron Center for STEM Education and Career Development.

"Once you have a STEM-based education," he tells students, "it prepares you for a career in just about anything."

Markowitz said he is thrilled to see the Science Pavilion construction beginning as the Science Center's growth reflects the growth of the city.

"I think the Science Center has been a phenomenal institution for the past 26 years. As it continues to grow, I'm hopeful that even more students will be able to experience the great exhibits and programs that will come with the expansion," he said.

When he visits the Science Center with his family – wife Michelle and children Myer, 12, and Hannah, 8 – they head for Highmark SportsWorks® and the Miniature Railroad & Village®.

Myer and Hannah also enjoy exploring the hands-on exhibits featured in H2Oh! gallery.

"They have inquisitive minds," he said.

Mobile Fab Lab Embraces New, Creative Programming Opportunities

Traveling hundreds of miles, Carnegie Science Center's Mobile Fab Lab has brought makerspace equipment to 44 schools and community centers, making hands-on learning and innovation accessible to the Pittsburgh region.

Fab Lab Carnegie Science Center, launched in 2015, comprises an on-site digital fabrication laboratory and two mobile units. Fab Lab Carnegie Science Center, which is supported by Chevron as part of its Appalachia Partnership Initiative, is part of a global network of more than 500 Fab Labs.

Both on-site and mobile Fab Labs include 3D printers, laser cutters, computers, software, and other cutting-edge technologies that enable people to design and create nearly anything. Programs range from public workshops for Science Center visitors, to field trips for students as young as third grade, to professional development opportunities for educators. In the 2015–2016 school year, the Mobile Fab Lab served 3,900 people.

A $200,000 grant from BNY Mellon Foundation of Southwestern Pennsylvania has provided the Science Center with a second mobile Fab Lab, increasing the Science Center's capacity to meet the STEM education and career needs of underserved students and communities throughout the region. The grant includes 80 free visits by the new Fab Lab van to a total of 2,500 students at under-resourced schools and community organizations.

The Mobile Fab Lab also provides greater opportunities for Science Center staff to tailor programming around a school's specific curriculum, creating a more enriching experience for students.

"Intercurricular programming is the best," Fab Lab Mobile Education Coordinator **Jon Doctorick** said. "When our programming ties in with what kids are doing in class in a fun and hands-on way – that's when they really learn and remember the most."

Ultimately, Doctorick hopes to establish a full fleet of mobile Fab Lab vans, so programs can be taught simultaneously at multiple schools and community centers.

Currently, the Fab Lab is developing a new mentorship program in which kids age 14 and up can learn about digital fabrication and explore STEM careers alongside adult professional mentors. The mentorship program, scheduled to launch by Fall 2017 with funding provided by Partner4Work, is envisioned to provide students with one-on-one guidance as they learn to use the Fab Lab's design software and equipment. Upon completion of the mentorship program, students will receive a laptop that contains software to enable them to continue experimenting with their new technical skills.

Looking toward the future, the Fab Lab staff plans to continue expanding its programming and role as both a local center and an international resource for education and innovation. "Our goal is to form a network of makers that come to the Science Center," Doctorick said. "We want to be seen as leaders in teaching kids to love science and innovation, and as one of the major tech centers and makerspaces in Pittsburgh and the world. When people think of 3D printing, CAD programming, and making something, we want them to think of the Fab Lab."

Carnegie Science Center Mini-Grants Support Schools' STEM Initiatives

Funds Awarded to Eight Schools in STEM Excellence Pathway

A STEM career fair, makerspace programming, and computer science educational fairs are among the new initiatives introduced at local schools this winter through mini-grants from Carnegie Science Center.

Working in collaboration with The Heinz Endowments, the Science Center gave mini-grants to eight local schools participating in the Carnegie STEM Excellence Pathway. The Pathway is a continuous improvement process developed by the Science Center in which schools evaluate themselves on criteria pertinent to quality STEM education, then develop plans for ongoing improvement. Currently the Pathway is being used by more than 8,200 schools in 19 states and the District of Columbia, encompassing four million students.

Locally, the $3,000 mini-grants are helping schools in Westmoreland and Allegheny Counties support their commitment to improving STEM education

At Blackhawk School District, a small rural school district northwest of Pittsburgh, the mini-grant funded the purchase of 3D printers.

Pathway Partners Mini-Grant Recipients:

- **Baldwin-Whitehall School District**
- **Deer Lakes School District**
- **South Allegheny School District**
- **Forbes Road Career & Technology Center**
- **Our Lady of Grace School**
- **St. Rosalia Academy**
- **Woodland Hills Academy**
- **Yough School District**

These schools are in Allegheny and Westmoreland Counties, and more than half of them are under-resourced schools.

"The part of our grant that was unique is that our high school students were the ones that would be building the 3D printers and helping to accommodate the printers to the need of each of the buildings," **Dale Moll**, Blackhawk's technology & engineering education teacher, said. "Since the students built the printers, they are now also the tech support. So if anything doesn't work right or breaks, the printer will be sent over to the high school for repairs."

Our Lady of Grace, a parochial school, is striving to increase parents' awareness of STEM education and workforce needs. Through the mini-grant, Our Lady of Grace will integrate makerspace projects into the curriculum and provide opportunities for families to engage in STEM learning.

Middle-school students from Yough School District, a large rural school district east of Pittsburgh, will be able to hone their problem-solving skills through robotics and coding activities. The grant will fund robotics and circuitry materials, providing the supplies for students to design and build personalized robotic projects. At Yough School District, teachers plan to use these supplies both for in-class lesson plans and for extracurricular activities.

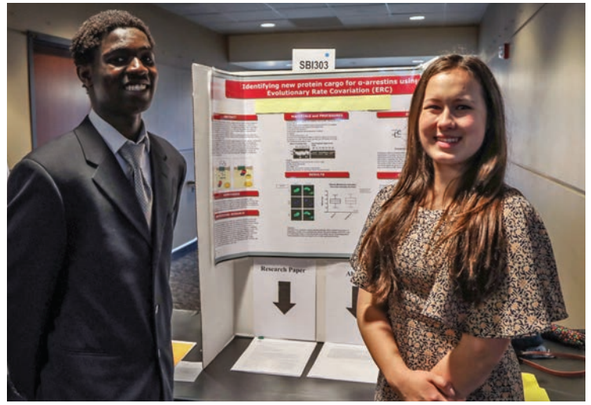
"The Pathway Partner schools are using these mini-grants in such imaginative and impactful ways, from teacher professional development to 3D printing to digital video production," said **Alana Kulesa**, Carnegie Science Center's director of Strategic Education Initiatives. "It's gratifying to see how these funds are making a positive impact as schools continually strive for STEM excellence."

Photo Essay: 2017 Covestro Regional Science & Engineering Fair

Covestro's Paige Kassalen, the only U.S. female engineer on the ground crew of Solar Impulse, served as an inspiring keynote speaker. Kassalen helped the team achieve its mission to complete the first-ever, round-the-world flight without using a single drop of fossil fuel. Paige was named to Forbes magazine "30 Under 30" Class of 2017. She is a market analyst at Covestro, where she explores how innovative materials will shape the future of mobility and continues to be an inspiring voice in STEM.

More than 1,000 students representing schools throughout the region competed in Carnegie Science Center's 78th annual Covestro Pittsburgh Regional Science & Engineering Fair — one of the oldest and largest science fairs in the nation. The event was held on March 31 and April 1 at Heinz Field. Four students were selected to represent the region at the Intel International Science & Engineering Fair to be held in May in Los Angeles.

Students at the Science Fair awards ceremony listen intently as Keynote Speaker Paige Kassalen discusses her work on the ground crew of Solar Impulse.



To complete their Science Fair projects, students explore scientific concepts and also hone their presentation skills in front of judges. More than 600 judges representing local companies and universities review the students' projects.

Photos taken by Roy Engelbrecht, courtesy of Covestro LLC

GRANTS & AWARDS

- **The Pittsburgh Steelers** awarded the Science Center a $100,000 grant in support of general operations.
- **Bayer USA Foundation** has renewed its commitment as a Founding Partner of the Chevron Center for STEM Education and Career Development with a two-year, $100,000 grant.
- A $40,000 grant from the **Buhl Foundation** will enable the Science Center to develop a mobile Fab Lab program called *Robots on Mars*. The project will challenge fourth-grade North Side students to explore careers in the design and aerospace industries.

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At Carnegie Science Center's *Dream Big* Girls Night Out Engineering Challenge, a team inspects their engineering feat. Girls took on the challenge of building a tower as tall as possible using just paper and tape.

Read more about the *Girls Night Out* Engineering Challenge in the cover story.