IMPACT CASE STUDY

Filling the STEM gap in Michigan

AT-A-GLANCE

***FIRST*® in Michigan runs one of the oldest and largest robotics organizations in the United States, building on a historic collaboration between *FIRST,*® the State of Michigan, the auto industry, the Michigan school systems, and the students and volunteers who make it thrive.**

Michigan and STEM

The auto industry drives STEM job growth in Michigan, and engineers are in high demand. In fact, about 45 percent of all Michigan STEM jobs are in engineering. STEM jobs are expected to grow at an annual rate of 5 percent per year from 2014 to 2024, according to the Georgetown Center on Education and the Workplace.[1] Robotics technologies like shop floor automation and self-driving cars are helping drive that growth. Alumni of *FIRST* programs who go on to college and major in STEM disciplines are well equipped for this vibrant, technologically driven job market.

FIRST® in Michigan

FIRST programs came to Michigan in 1993 after *FIRST* founder Dean Kamen brought the idea to his longtime friend François J. Castaing, then at Chrysler. Castaing pitched *FIRST* to the Big Three automakers – Chrysler, Ford, and General Motors. They immediately recognized the value of introducing Michigan kids to STEM and engineering at a young age. In 2008, the program was reorganized, customizing its approach to include more frequent local competitions and greater representation among Michigan schools. Michigan Governor Rick Snyder, a vocal supporter of *FIRST*, has invested millions in grant funding for school districts to establish *FIRST* teams, making *FIRST* the flagship STEM after-school program in Michigan.

Growth and opportunity

FIRST in Michigan reaches more than 28,000 K-12 students and mentors on 1,700 teams. *FIRST* teams are in roughly 60 percent of the state's high schools.

Research from Brandeis University shows that participation in *FIRST* programs results in positive outcomes for students, such as gains in STEM interest, STEM career interest, and 21st century skills – including teamwork, problem solving, time management, and communication. Eighty-six percent of students are more interested in doing well in school after participating in *FIRST*, and 88 percent are more interested in going to college. Eighty percent of students are more interested in jobs that use STEM.[2]

Among the class of 2017, nearly half of Michigan boys (47.1 percent) and 15 percent of Michigan girls expressed interest in STEM careers, according to Michigan's 2016 STEM Report Card.

BY THE NUMBERS

Michigan is one of the largest state-based *FIRST* organizations in the country, with more than 1,700 teams from kindergarten through 12th grade.

***FIRST* Robotics Competition**
454 teams

***FIRST* Tech Challenge**
346 teams

***FIRST* LEGO League**
489 teams

***FIRST* LEGO League Jr.**
422 teams

FIRST® builds a pipeline from K-12 to STEM success in Michigan

Robotics drive the future for Michigan and the auto industry

The auto industry has long fueled voracious demand for STEM grads in Michigan. Auto companies particularly seek out engineering talent. According to the Bureau of Labor Statistics, there are more mechanical engineers per capita working in Michigan than in any other state, and these jobs are expected to grow at an annual rate of 5 percent per year through 2024, according to the Georgetown Center on Education and the Workplace.[4]

FIRST® in Michigan has been an important factor in the state of Michigan's drive to inspire students to pursue STEM in college and beyond. Among the class of 2017, nearly half of Michigan boys (47.1 percent) and 15 percent of Michigan girls expressed interest in STEM careers, according to Michigan's 2016 STEM Report Card.[5] That's up dramatically among boys. For the class of 2008, only 38.8 percent wanted to work in STEM. Interest has also surged among several minority groups in the state, particularly American-Indian students and Hispanic students from the class of 2016.

Emerging technology trends in the auto industries, including the move to automated production and the development of self-driving cars, are currently creating robust employment opportunities for robotics engineers – many of them in Michigan. As of 2015, there were nearly 58,000 robotics jobs in the state, the third most of any state in the country, per the governor's office.[6] *FIRST* alumni who go on to college in STEM disciplines are well equipped for this vibrant, technologically driven job market.

FIRST in Michigan teaches 21st century skills

Since its founding in 1989 by inventor Dean Kamen, *FIRST* has inspired young people to become science and technology leaders and innovators, by creating a culture where scientists and engineers are celebrated as widely and loudly as athletes and celebrities. Today, it's more important than ever to show kids that their academic performance is as important as athletics. That's why *FIRST* has developed a *Sport for the Mind*™ – a progression of exciting, team-based robotics competitions, allowing kids to develop hands-on skills using increasingly complex STEM concepts from kindergarten through 12th grade.

- *FIRST*® LEGO® League Jr., for kids in grades K-4, captures young curiosity by having students explore real-world scientific challenges, learn teamwork, and work with motorized LEGO® elements.
- *FIRST*® LEGO® League, for grades 4-8, asks students to research a real-world engineering challenge, develop a solution, and compete with autonomous LEGO-based robots of their own design.
- In the *FIRST*® Tech Challenge program, students in grades 7-12 form teams and are challenged to design, build, and program a robot to play a floor game against other teams' creations.
- In the *FIRST*® Robotics Competition, high school teams (grades 9-12) compete head to head on a special playing field with 120-pound robots they've designed, built, and programmed.

More than 20 years of collaboration with automakers

FIRST in Michigan has had support from the beginning from auto industry executives who see its hands-on training in engineering and technology as a vital pipeline of future talent. Ken Morris, vice president of global product integrity at General Motors (GM), explains, "To move the automotive industry and countless others forward into a rapidly approaching future, we need more engineers and students well-versed in technology and the building blocks, like science and math."

"We're looking at a huge gap in well-educated and prepared college graduates to lead the next generation of engineering innovation. Programs like *FIRST* make science and engineering come to life," Morris adds. "Through problem-solving and teamwork, students learn a lot, have fun, gain confidence, and – most importantly – stay interested in these vital

"We have noticed that students who come from *FIRST* not only have the necessary skills and passion for engineering, but also exhibit the types of behaviors we look for at GM, like problem solving and collaboration."

— KEN MORRIS, VICE PRESIDENT OF GLOBAL PRODUCT INTEGRITY, GENERAL MOTORS

subject matters. One of the greatest assets of this program is that students emulate the real world of engineering very closely."

GM has hired hundreds of *FIRST* alumni as engineers and technicians. "We have noticed that students who come from *FIRST* not only have the necessary skills and passion for engineering, but also exhibit the types of behaviors we look for at GM, like problem solving and collaboration," says Morris.

One notable *FIRST* alum at GM is Kyle Vogt, who co-founded the autonomous driving startup Cruise Automation, which GM acquired in 2016 for over $500 million.

GM supports the program with grants that fund registration for beginning teams, and by encouraging its employees to get involved. Morris notes that over 100 GM people are currently volunteering with *FIRST* teams. "Not only is it personally rewarding, GM has seen the fruits of their dedication to *FIRST* in the form of attracting the students on these teams to join our company after graduating from an accredited engineering program," he says.

The value of problem-solving, technology-adept *FIRST* alumni will only become more compelling in the years to come. "Emerging technologies are transforming the auto industry and the vehicles we develop. A new set of skills will be needed to engineer and design tomorrow's cars, and many of those jobs will be here in our home state of Michigan," says Morris. "Electrification and connectivity are the cornerstones of the autonomous future. We are rapidly transforming our engineering teams in order to develop or obtain the skills required to continue to be a leader in these areas."

Visionary support from the state of Michigan

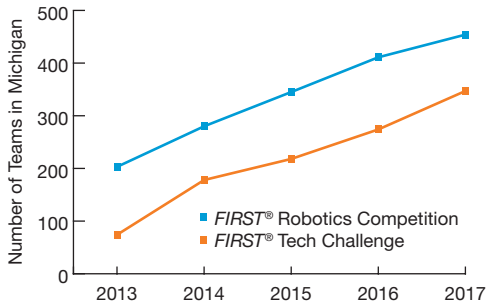
Championed by Michigan Governor Rick Snyder, *FIRST* has become the state's premier STEM-based after-school program. For the 2013-2014 school year, the state of Michigan marked $3 million for grants for school districts to fund *FIRST* Robotics Competition and *FIRST* Tech Challenge teams. The grant is funded through an appropriation under the Michigan State School Act, Section 99h. The state invested another $2 million in the grant program for 2014-2015 and again in 2015-2016. During the 2016-2017 school year, the state made $2.5 million available to expand the grants to include *FIRST* LEGO League and *FIRST* LEGO League Jr. teams. During the 2016-2017 season, Michigan was home to more than 1,700 *FIRST* teams across all four programs, making it one of the largest state-based *FIRST* organizations in the country.

Michigan Governor Rick Snyder meets with FIRST LEGO League Team 4182 "Techno Tadpoles" during the 2017 North American International Auto Show in Detroit.

FIRST in Michigan President Gail Alpert says that Governor Snyder took an immediate interest in *FIRST* after attending the *FIRST* Robotics Competition Michigan State Championship for the first time in 2012 and becoming excited about the program's workforce development potential. In addition to advocating for funding, Governor Snyder has actively promoted the program. He has invited *FIRST* participants and alumni to his annual Michigan State of the State Address and recognized their achievements (see sidebar on page 4, Harrison Ford).

Governor Snyder also celebrated when *FIRST* announced Detroit would be one of two host cities for its international *FIRST* Championship events from 2018 to 2020. "Michigan has long been a global leader in design and engineering, and *FIRST* is a program that is inspiring the next generation of innovators," the governor said.

IMPACT OF STATE OF MICHIGAN GRANT ON *FIRST* TEAM GROWTH



Source: FIRST in Michigan

ALUM SPOTLIGHT

Harrison Ford: From *FIRST* LEGO League to *FIRST* Mentor

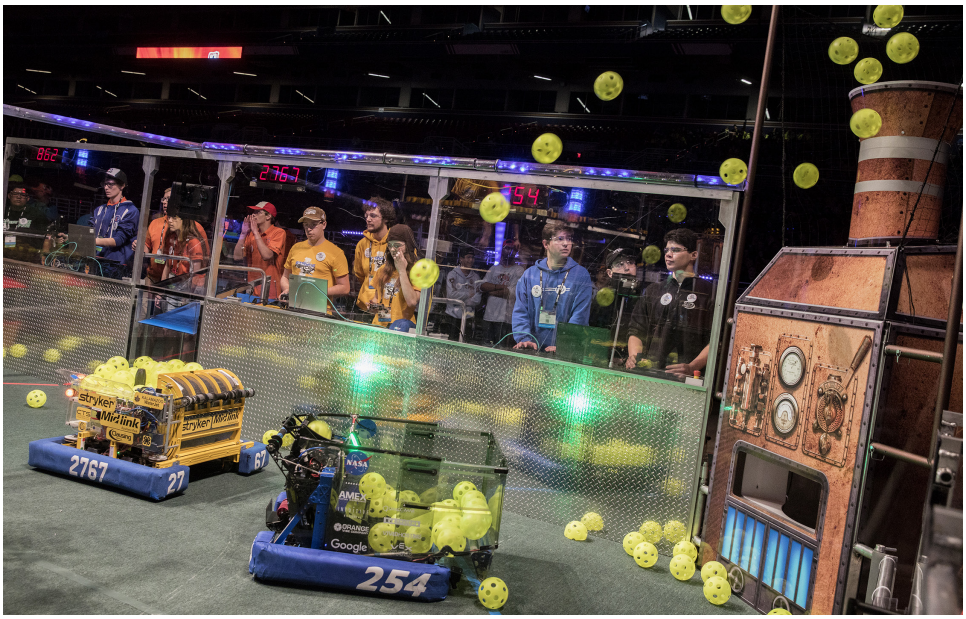
Harrison Ford—no relation to the actor—got his start with *FIRST* LEGO League in fifth grade at his elementary school in Flint, Michigan. He'd always been fascinated by science and invention, but says he probably wouldn't have gotten involved in STEM without *FIRST*. "I would have been interested in robotics, but I wouldn't have had the exposure. There were no other STEM-related programs in my school," he explained.

Family difficulties forced a hiatus in high school, but he came back senior year and won a *FIRST* scholarship to Kettering University. His experience with *FIRST* prepared him for college, both academically and on a personal level. He learned to use basic tools and took a CAD course, skills that paid off at Kettering.

The real benefit was the way it enlarged his world. "As an African American coming from Flint, I got to see many different types of communities and had relationships with other people and cultures that I never would have been exposed to," Ford said. "I can learn technical skills by reading a book. I can't learn about people unless I actually get to meet them."

Today as a mentor, he's introducing a new generation of kids to *FIRST*. "The majority of kids that I have on my team are inner-city kids, and they come with their own backgrounds, stories, and problems," Ford explained. "As a mentor, I focus on trying to build them into better individuals rather than trying to get them to hurry up and build a robot. The ultimate goal is for them to go to college or learn a trade." At the *FIRST* Robotics Community Center at Kettering, team members get tutoring, as well as robotics training, and there are strict academic standards for participating in away meets and out-of-state trips.

Ford's team has had success sending kids to college. One alumna of his team is now enrolled at Kettering. An alumnus got a full ride to Western Michigan. As for Ford, he's now working full-time for Chrysler. And, after speaking at the Kettering *FIRST* Center's opening ceremony alongside *FIRST* Founder Dean Kamen and Governor Snyder, he's become one of *FIRST* in Michigan's best spokespersons. He was recently invited to Governor Snyder's State of the State address, where he and *FIRST* in Michigan were recognized.



Two Michigan FIRST Robotics Competition teams – Team 862 "Lightning Robotics" of Canton and Team 2767 "Stryke Force" of Kalamazoo – compete together on the winning alliance at FIRST Championship 2017 in St. Louis.

Customizing *FIRST* to meet Michigan's needs

FIRST in Michigan was reorganized in 2008 to serve the state's unique needs, and these changes have provided a springboard for dramatic growth. *FIRST* in Michigan overhauled its schedule so that kids could compete more frequently and closer to home. New competitions were moved into high school gyms. "Everybody from superintendents, school administration, teachers, and your friends and family come watch," says Alpert. The excitement and accessibility of these competitions drew more students to *FIRST*.

Another priority for *FIRST* in Michigan has been extending participation into every part of the state, from college-prep-focused high schools in Detroit's upscale suburbs to the inner-city communities of Flint and Detroit to the rural high schools of Michigan's Upper Peninsula.

For high school students, the *FIRST* Robotics Competition offers students real-world engineering experience through challenges that change each year. When Alpert took over Michigan's *FIRST* Robotics Competition program in 2008, she focused on growing it in Michigan high schools. Alpert divided the state into 16 districts and began calling school superintendents one by one to sell the benefits of *FIRST*. For under-resourced schools, Alpert has been able to offer three-years' worth of grant money to get them started. As the programs grow, schools typically find their own sponsors, but the first few years can be a stretch. "The State of Michigan's grant to schools makes *FIRST* accessible to all, whether they're rural, urban, or suburban schools," says Alpert. "It gives schools time to get their program off the ground and partner with local companies."

Teachers who are just starting *FIRST* Robotics Competition teams sometimes worry they don't have the time or expertise in robotics to

FIRST mentor and alum Harrison Ford works with students on FIRST Robotics Competition Team 322 "Flint FIRE" at the FIRST Robotics Community Center at Kettering.

"The State of Michigan's grant to schools makes *FIRST* accessible to all, whether they're rural, urban, or suburban schools. It gives schools time to get their program off the ground and partner with local companies."

— GAIL ALPERT, *FIRST* IN MICHIGAN PRESIDENT

FIRST participants work on their robot at the FIRST Center at Kettering in Flint, Michigan.

run their teams. To help, *FIRST* in Michigan offers a number of support programs, including weekly conference calls to get new teams acclimated, as well as pre-season robotics workshops for teachers and kids. Once the robotics kits have been distributed in January, *FIRST* in Michigan runs chassis-building workshops throughout the state. "Right after the season begins, the new teachers pick up their Kit of Parts and realize there are no instructions," Alpert says. "We have workshops that get them running and excited about the program."

Today *FIRST* has high school teams in about 60 percent of Michigan schools – and the program is growing so rapidly that some schools field two teams. "That's what is really exciting about *FIRST* in Michigan: We see great talent and diversity coming from every corner of the state. If a child is interested in engineering, *FIRST* helps open the door no matter their background," says GM's Ken Morris.

Creating a space for *FIRST* teams

FIRST Robotics Competition teams need tools, computers, machinery, and a place to work. Many high schools don't have the necessary equipment, so *FIRST* in Michigan established community centers where *FIRST* teams can meet after school to share resources while building their robots. The Michigan Engineering Zone, or MEZ, sponsored by the University of Michigan, was the first of its kind. Located in the heart of Detroit, it now houses nearly 20 teams.

Bob Nichols is the Director of the *FIRST* Robotics Community Center, which opened in 2014 at Kettering University in Flint, Michigan. The *FIRST* Center houses a shared workspace for eight *FIRST* Robotics Competition teams, including a machine shop, design and programming lab, and practice field. The *FIRST* Center partners with Flint schools and the Crim Fitness Foundation to train teachers, mentors, and students.

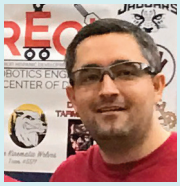
The *FIRST* Center also offers a practice field, off-season events, and summer camps for *FIRST* LEGO League Jr., *FIRST* LEGO League, *FIRST* Tech Challenge, and *FIRST* Robotics Competition teams. It even hosts a two-week summer camp sponsored by Ford Motor Company that's specifically for Flint High School students, in which students get free SAT Prep training, learn to program an autonomous Ford Mustang, and design and build a robot. "I think the future of *FIRST* are centers like ours," says Nichols. "So many of our schools don't have the resources to support a robotics program. When we can provide space and equipment and mentoring, that makes *FIRST* possible for these schools."

FIRST in Michigan has another community center serving 11 *FIRST* teams in southwestern Detroit. The site is operated and managed in collaboration with the Detroit Hispanic Community Development organization (see sidebar on page 6, Joaquin Nuno-Whelan). Additionally, Mitch Albom's S.A.Y. Detroit Play Center, a recreational facility in northeast Detroit, integrates a robotics center into its after-school program that also includes tutoring, music, and sports.

Many *FIRST* alumni from Kettering University have gone on to work for the Big Three automakers.

MENTOR SPOTLIGHT

Joaquin Nuno-Whelan: Connecting Students with Role Models



FIRST has been so successful in Michigan that Joaquin Nuno-Whelan, General Motors' Chief Engineer, Next Gen Trucks, considers it part of GM's recruiting program. "These young engineers want to participate because it's a way for them to network and develop leadership skills," he said. "I also get to see who the high-potential young talents are and provide them with career guidance."

A few years ago, Nuno-Whelan partnered with the Detroit Hispanic Development Corporation (DHDC) in southwest Detroit to start *FIRST* teams in underserved communities. The program provided space and equipment, and has grown from two to 11 teams.

Nuno-Whelan works with *FIRST* Robotics Competition teams out of DHDC's Robotics Engineering Center of Detroit. The Center helps kids acquire and develop the skills needed to pursue careers in science and technology. "We'll have 200 kids and 50 or 60 mentors working together in one big space," said Nuno-Whelan. "There is just amazing energy."

"We want to give these same opportunities to kids who come from economically challenged neighborhoods," said Nuno-Whelan. "They get the opportunity to work one-on-one with mentors who have come to Detroit from all over the country and the world to work and participate in these programs."

The program just finished its third build season, and each year Nuno-Whelan sees more students pursue engineering or business degrees after graduation, inspired by *FIRST*.

Paulina Torres was among the first to move through the program, which includes about 50 percent female participants and several young female mentors, and companies are competing to hire her, says Nuno-Whelan. Nuno-Whelan is excited that his participants get the opportunity to work with Hispanic role models who are aspiring to engineering and STEM careers. "When I work with the kids and can point to one of our mentors and say, 'Do you realize you just did that better than that guy who graduated from MIT? If you can do this, you can do anything.' That's pretty cool."

FIRST mentor Joaquin Nuno-Whelan (fourth from right) with FIRST Robotics Competition Team 6616 "Mechanical Pumas" of Detroit at an event.

An academic pipeline

Robotics competitions are fun and exciting, but what kind of impact does *FIRST* in Michigan have on kids beyond the season? How does being on a *FIRST* team affect the rest of kids' lives?

Nationally-based research from Brandeis University shows that *FIRST* programs have a profound and lasting impact, including gains in STEM interest, STEM career interest, and 21st century skills such as teamwork, problem solving, time management, and communication. Eighty-six percent of students are more interested in doing well in school after participating in *FIRST*, and 88 percent are more interested in going to college. Eighty percent of students are more interested in jobs that use STEM.[7]

In support of sustaining that interest, the *FIRST* Scholarship Program connects *FIRST* Tech Challenge and *FIRST* Robotics Competition participants and alumni with colleges, universities, corporations, and associations, making available nearly 2,000 scholarship opportunities exclusively set aside for *FIRST* participants. During the 2016-2017 academic year, $50 million in college scholarship opportunities were made available by nearly 200 scholarship providers to *FIRST* participants and alumni.

In Michigan, the *FIRST* relationship with Kettering University provides opportunity and scholarships. Since 1999, Kettering University, an engineering and STEM-focused college in Flint, has awarded over $4 million in scholarships to *FIRST* alumni from all over the country. This year alone, Kettering awarded 37 scholarships to students involved in *FIRST*. About a third of the current Kettering student body joined a *FIRST* team in high school."

The emphasis *FIRST* puts on hands-on engineering skills fits perfectly with Kettering's commitment to on-the-job learning. Students at Kettering supplement their education with co-op jobs, studying three months in the classroom and then working for three months, throughout their four years at the school. "Corporations love students that were in *FIRST* in high school, because they come with skills that most high school students don't have," says Nichols.

...that fast-paced, think-on-your-feet experience builds strong 21st century work-life skills in *FIRST* participants: "That builds a lot of leadership skills, teamwork skills, problem-solving skills that you just don't see in high school students."

— BOB NICHOLS, DIRECTOR, *FIRST* ROBOTICS COMMUNITY CENTER

At *FIRST* competitions, teams set up NASCAR-like pits so they can tinker with their robots and make fixes or improvements between matches. Nichols says that fast-paced, think-on-your-feet experience builds strong 21st century work-life skills in *FIRST* participants: "That builds a lot of leadership skills, teamwork skills, problem-solving skills that you just don't see in high school students."

Many *FIRST* alumni from Kettering University have gone on to work for the Big Three automakers. A large number of them also give back by mentoring high school *FIRST* Robotics Competition teams at the *FIRST* Center at Kettering, creating a cycle where more and more kids are introduced to STEM skills that can change their lives. "Many of them had no intention of being an engineer or scientist when they started on the team, but they figure out pretty fast that, wow, this is fun. I'd like to do this some more," says Nichols.

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1 "STEM: State-Level Analysis" by Anthony P. Carnevale, Nichole Smith and Michelle Melton, Georgetown Center on Education and the Workplace, 2016

2 Brandeis University: Cross-Program Evaluation of *FIRST* Tech Challenge and *FIRST* Robotics Competition (2011); Evaluation of the 2012-13 *FIRST* LEGO League Program (2013); *More than Robots*: Evaluation of *FIRST* Robotics Competition Participant and Institutional Impacts (2005)

3 Bureau of Labor Statistics, Occupational Employment and Wages, May 2016 https://www.bls.gov/oes/current/oes172141.htm#st

4 "STEM: State-Level Analysis" by Anthony P. Carnevale, Nichole Smith and Michelle Melton, Georgetown Center on Education and the Workplace, 2016

5 "Michigan's 2016 STEM Report Card," ASTRA's 2016 STEM Innovation Vital Signs Series http://usinnovation.org/state/pdf_cvd/ASTRA-STEM-on-Hill-Michigan2016.pdf

6 "Ten things you need to know about *FIRST* Robotics in Michigan" by Josh Paciorek, Office of the Governor of Michigan, 2015 http://www.michigan.gov/snyder/0,4668,7-277-57577_60279-352345--,00.html

7 Brandeis University: Cross-Program Evaluation of *FIRST* Tech Challenge and *FIRST* Robotics Competition (2011); Evaluation of the 2012-13 *FIRST* LEGO League Program (2013); *More than Robots*: Evaluation of *FIRST* Robotics Competition Participant and Institutional Impacts (2005); *FIRST*, 2015 Survey of *FIRST* Robotics Competition and *FIRST* Tech Challenge Alumni

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