

**STEM IN ACTION:
INSPIRING THE SCIENCE AND
ENGINEERING WORKFORCE OF TOMORROW**

HEARING
BEFORE THE
**COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY**
HOUSE OF REPRESENTATIVES
ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

TUESDAY, SEPTEMBER 13, 2011

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**STEM IN ACTION:
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ENGINEERING WORKFORCE OF TOMORROW**

TUESDAY, SEPTEMBER 13, 2011

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:04 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph Hall [Chairman of the Committee] presiding.

RALPH M. FALL, TEXAS
CHAIRMAN

EDDIE BERNICE JOHNSON, TEXAS
RANKING MEMBER

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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STEM in Action:
Inspiring the Science and Engineering Workforce of Tomorrow
Tuesday, September 13, 2011
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witness List

Mr. Tony Norman

President and CEO of Innovation First International, Inc.

Mrs. Nancy Conrad

Chairman and Founder of the Conrad Foundation

Mr. Michael D. Gallagher

President and CEO of Entertainment Software Association

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

**STEM in Action:
Inspiring the Science and
Engineering Workforce of Tomorrow**

TUESDAY, SEPTEMBER 13, 2011
10:00 A.M.—12:00 P.M.

2318 RAYBURN HOUSE OFFICE BUILDING

1. Purpose

On Tuesday, September 13, 2011, the Committee on Science, Space, and Technology will hold the second in a series of hearings to highlight Science, Technology, Engineering, and Math (STEM) education activities across the Nation, their role in inspiring and educating future generations, and their contribution to our future economic prosperity. The purpose of this hearing, *STEM Education in Action: Inspiring the Science and Engineering Workforce of Tomorrow*, is to showcase a variety of public/private partnerships and initiatives that are successfully inspiring the future STEM workforce.

2. Witnesses

- **Mr. Tony Norman**, President and CEO of Innovation First International, Inc.
- **Mrs. Nancy Conrad**, Chairman and Founder of the Conrad Foundation
- **Mr. Michael D. Gallagher**, President and CEO of Entertainment Software Association

3. Overview

- In the U.S, student mastery of STEM subjects is essential for 21st century jobs. Finding ways to improve STEM education activities beyond the scope of the federal government, including using best practices derived from non-federal sources, is key to the future prosperity of the Nation.
- The Administration's FY 12 Budget request includes \$3.4 billion in spending for STEM education efforts.
- A growing number of partnerships between industry, foundations, non-profits, and local and regional governments recognize the importance of having an educated and skilled STEM workforce and are creatively motivating and inspiring future generations of scientists and engineers with little or no federal funding.
- Innovation First International began by producing electronics for autonomous mobile ground robots and is now a leader in educational and competitive robotics products, and a growing developer of consumer robotics toys. Through Innovation First International, VEX Robotics motivates students in the classroom with its VEX Robotics Classroom competition as well as a number of other competitions around the Nation.
- The Conrad Foundation is a non-profit, 501(c) (3) organization built upon astronaut Charles "Pete" Conrad's history of innovation and entrepreneurship. The Spirit of Innovation Awards, a competition founded by the Conrad Foundation, challenges teams of high school students to create innovative products to solve 21st century, real-world problems.
- The Entertainment Software Association (ESA) is the U.S. association dedicated to serving the needs of companies that publish computer and video games for video game consoles, personal computers, and the Internet. ESA is one of the annual sponsors of the STEM Video Game Challenge which aims to motivate interest in STEM learning among America's youth by tapping into students' desire to play and make video games.

4. Background

STEM Education and the Federal Government

A consensus exists that improving STEM education throughout the Nation is a necessary condition for preserving our capacity for innovation and discovery and for ensuring U.S. economic strength and competitiveness in the international marketplace of the 21st century. The National Academies *Rising Above the Gathering Storm* report placed major emphasis on the need to improve STEM education and made its top priority increasing the number of highly qualified STEM teachers. This recommendation was embraced by the House Science, Space, and Technology Committee following the issuance of the report and was included in the 2007 *America COMPETES Act*. The 2010 *America COMPETES Reauthorization Act* continues this priority.

Beyond activities authorized in America COMPETES, President Obama has called for a new effort to prepare 100,000 STEM teachers with strong teaching skills and deep content knowledge over the next decade. As a component of achieving this goal, the FY 12 Budget Request proposes an investment of \$100 million through the Department of Education and the National Science Foundation (NSF) to prepare effective STEM teachers for classrooms across America. This proposal also responds to a recommendation by the President's Council of Advisors on Science and Technology (PCAST) to prepare and inspire America's students in STEM.¹

In addition, the FY 12 Budget Request proposes \$90 million for the creation of an Advanced Research Projects Agency—Education (ARPA-ED) with the mission of driving transformational improvement in education technology.²

The President's new "Educate to Innovate" campaign leverages federal resources with over \$700 million in private-sector resources. The goals of the program are to increase STEM literacy so that all students can learn deeply and think critically in science, math, engineering, and technology; move American students from the middle of the pack to the top in the next decade; and expand STEM education and career opportunities for underrepresented groups, including women and girls.

With specific regard to K–12 STEM education funding beyond what has already been identified, the FY 12 Budget Request calls for \$206 million for the Department of Education's proposed Effective Teaching and Learning in STEM program; a \$60 million (28 percent) increase for NASA's K–12 education programs; \$300 million for an "Investing in Innovation" program (expansion of a Department of Education American Reinvestment and Recovery Act program); and \$185 million for a new Presidential Teaching Fellowship program.

In total, the FY 12 Budget Request devotes \$3.4 billion to STEM education programs across the federal government.³ The 2010 *America COMPETES Reauthorization Act* called for the creation of a National Science Technology Council (NSTC) Committee on STEM Education to coordinate federal STEM investments. The first-year tasks of the Committee are to create an inventory of federal STEM education activities and develop a five-year strategic federal STEM education plan. The inventory, as well as a similar Government Accountability Office (GAO) survey requested by the Committee on Education and Workforce, is currently underway and results are expected before next year.

In the 112th Congress, the Science, Space, and Technology Committee will continue to hold oversight hearings and briefings on STEM education activities across the federal government and will closely monitor the scope and findings of both the NSTC and the GAO federal STEM education inventories.

Public-Private Partnerships and STEM Education

In the U.S., student mastery of STEM subjects is essential for 21st century jobs. As other nations continue to gain ground in preparing their students in these critical fields, the U.S. must continue to explore a variety of ways to inspire future generations. Finding ways to improve STEM education activities beyond the scope of the federal government, including using best practices derived from non-federal sources, is key to the future prosperity of the Nation.

¹White House Office of Science and Technology Policy, *Winning the Race to Educate Our Children*, STEM Education in the 2012 Budget, p.1

²White House Office of Science and Technology Policy, *Winning the Race to Educate Our Children*, STEM Education in the 2012 Budget, p.1

³White House Office of Science and Technology Policy, *Innovation, Education, and Infrastructure: Science, Technology, STEM Education, and 21st Century Infrastructure in the 2012 Budget*, p. 2.

A growing number of partnerships between industry, foundations, non-profits, and local and regional governments recognize the importance of having an educated and skilled STEM workforce and are creatively motivating and inspiring future generations of scientists and engineers with little or no federal funding. Such partnerships can provide alternative options for education activities outside the scope of public financing and delivery. When designed, implemented and run effectively, a successful partnership can increase efficiency and choice and expand access to educational activities not necessarily found in the classroom. Oftentimes, public-private partnerships allow state and local governments to leverage the specialized skills offered by certain private organizations. Likewise, industry seeks a substantial return on its investment with a highly skilled, highly motivated workforce.

Innovation First International and Vex Robotics Competition

Innovation First International began by producing electronics for autonomous mobile ground robots and is now a leader in educational and competitive robotics products, and a growing developer of consumer robotics toys. Incorporated in 1996, Innovation First International is a privately held corporation that was founded on the belief that innovation is necessary very early in the design process to produce simple and elegant product designs.

Through Innovation First International, the VEX Robotics Design System is the leading classroom robotics platform designed to nurture creative advancement in robotics and knowledge of science, technology, engineering and math (STEM) education. The VEX platform is expanding rapidly and can be found in middle schools, high schools and university labs around the globe. VEX Education works to help schools focus on practical, affordable and accessible ways of delivering dynamic hands-on STEM educational experiences to as many students as possible. VEX addresses current educational and societal needs by its mixing of competition and the real-world applications of mathematics and science concepts through the engineering design process.

VEX Robotics⁴ has found a way to motivate students in the classroom with its VEX Robotics Classroom competition. The co-curricular program is specifically tailored to bring robotics competition into the classroom. Robotics can provide an engaging way to integrate all facets of STEM education into the classroom, and head-to-head competition is a natural way to capture students' attention. The VEX Robotics Competition is the largest and fastest growing middle and high school robotics program globally with more than 3,500 teams from 20 countries competing in more than 250 tournaments worldwide. In the U.S., VEX Robotics Competition events are held in numerous states. The Technology Student Association (TSA) and VEX have also partnered to spread the word about STEM education and competition. There are currently three available TSA VEX competitions around the country.

Innovation First and Vex Robotics partners include the REC Foundation, Autodesk, NASA, BEST, Project Lead The Way, Northrop Grumman, Technology Student Association (TSA), SkillsUSA, EMC Corporation, Carnegie Mellon University, Intelitek, Microchip, the United States Coast Guard Academy, iD Tech Camps, Automation Direct and the CREATE Foundation.

The Conrad Foundation and the Spirit of Innovation Awards

The Conrad Foundation is a non-profit, 501(c) (3) organization built upon astronaut Charles "Pete" Conrad's history of innovation and entrepreneurship. His legacy continues through the Conrad Foundation's programs that combine science, education, and entrepreneurship in a revolutionary model of incentivized competition.

The Spirit of Innovation Awards⁵, a competition funded by the Conrad Foundation, challenges teams of high school students to create innovative products using science, technology, and entrepreneurship to solve 21st century, real-world problems. Eligible students may compete on teams in any of three challenge categories: aerospace exploration, clean energy, or cybersecurity.

In each category, students create a team with a maximum number of five students, find and consult a mentor in the community to help provide expert guidance and feedback, and create a proposal. After judging, each team is matched with a set of three mentors who are experts in the field and with whom they collaborate. Each team must then create a next step plan video including an executive summary, budget, and timeline. The public then votes on each team in a people's choice voting process. Each winning team is recognized as Pete Conrad Scholars for that year. Winners receive a \$5000 cash grant to continue the development of their product

⁴<http://www.vexrobotics.com/competition>

⁵<http://www.conradawards.org/competition>

as outlined in their Next Step Plan. Finalists then have the chance to attend the Innovation Summit which is the culmination of the Conrad Foundation's Spirit of Innovation Awards program and is the launch pad for breakthrough technologies from high school innovators. Leading entrepreneurs, government officials, and scientists join the top young innovators and their teachers in a collaborative, social forum to help build the progressive technologies and the next-generation workforce of the 21st century.

The Conrad Foundation, through the Spirit of Innovation Awards, attempts to create a collaborative community focused on scientific innovation, education, and entrepreneurship. The program creates life-long opportunities for all students and teachers participating in the program. The "Portal" was created to provide an opportunity to help teams with market potential achieve commercialization. It serves as an advisory group to the team and provides intellectual property, legal, business, and technical guidance. It is not limited to just the winners of the competition. Past winners and finalists have formed an Alumni Committee to help increase the exposure of and opportunities for all students participating in the program. As a result, students are provided a life-long, collaborative community of support.

The Conrad Foundation partners include Lockheed Martin, PepsiCo, Kraft Foods, American Institute of Aeronautics and Astronautics, American Society for Nutrition, the William James Foundation, NASA, National Institute of Health, Sigma Xi, museums and science centers, *Popular Science Magazine* and Space Ref.

Entertainment Software Association

The Entertainment Software Association (ESA) is the U.S. association exclusively dedicated to serving the business and public affairs needs of companies that publish computer and video games for video game consoles, personal computers, and the Internet.

Video games are no longer simply a form of entertainment for children and young adults. The industry, its customers, and its technology have significantly advanced in the past three decades. Entertainment software is now one of the fastest growing industries in the U.S. economy, and video games are driving technological and societal advancements that serve gamers and non-gamers alike.

Educators are increasingly recognizing the impact of entertainment software and utilizing games as a teaching device in a growing number of classrooms and business settings. In doing so, they are embracing the cultural and technological shifts of the 21st century and expanding the use of a favorite leisure activity, computer and video games, into a critical and still-emerging educational resource. More than just play, entertainment software is now being used to impart knowledge, develop life skills and reinforce positive habits in students of all ages. In addition to being a great way to keep students engaged, researchers have found that video games have real potential as next-generation learning tools. Games use new technologies to incorporate principles crucial to human cognitive learning.

The ESA is working in cooperation with the Information Technology Industry Council (ITI), Sony Computer Entertainment America (SCEA), Microsoft Corporation, and the MacArthur Foundation to harness the excitement surrounding computer and video games through a series of STEM-related video game design competitions.

One such competition is the National STEM Video Game Challenge, sponsored by the ESA, Microsoft, and the AMD Foundation, in partnership with the Joan Ganz Cooney Center at Sesame Workshop and E-Line Media. This competition was partly inspired by the White House *Educate to Innovate* campaign. The first National STEM Video Game Challenge⁶ featured two complementary competitions, a *Youth Prize* and a *Developer Prize*.

The *Youth Prize* engaged middle school students (grades 5 through 8) in STEM learning by challenging them to design original video games. The Youth Prize design challenge was open to middle school students from any U.S. school with a special emphasis on reaching students in underserved communities. Twelve winners were selected from a group of over 500 entries for their ability to use STEM concepts to design engaging, innovative and well-balanced games. Each winner received a lap-top computer, and \$2,000 for their school or non-profit organization of their choice (\$3,000 if the school is a recipient of Title 1 funding from the U.S. Department of Education).

The *Developer Prize* challenged emerging and experienced game developers to design mobile games, including games for the mobile Web, for young children that teach key STEM concepts and foster an interest in STEM subject areas. The grand

⁶<http://www.stemchallenge.org/Default.aspx>

prize winner received \$50,000 for their game that teaches children about the physical structure of bacteria and viruses, as well as how they are spread.

Chairman HALL. The Committee on Science, Space, and Technology will come to order, and I say good morning to all of you and welcome to today's hearing entitled "STEM in Action: Inspiring the Science and Engineering Workforce of Tomorrow."

Don't be dismayed by the empty seats here because everybody has several committees, and we are in kind of a crucial time in Congress right now when our ratings aren't the highest in the history of Congress and they are all working hard and trying to set in on several committees at one time. We have a court reporter over here that takes down everything you say and do and it goes into the Congressional Record, and people will read what you are saying and doing 100 years from now, and that is what is important, and every other Member of Congress gets a copy of your testimony and usually either they read it or somebody on their committee reads it to them, but they will be coming and going from time to time. Mr. Rohrabacher is here, and he is going to introduce because of personal friendship one of those of you that will be testifying.

In front of you are packets containing the written testimony and the biographies and the Truth in Testimony disclosures for today's witnesses. I will recognize myself for five minutes for an opening statement, and everybody will have—other opening statements will be put in the record.

So I say to you good morning. I would like to welcome everyone here today for the second in a series of STEM in Action hearings. The purpose of this hearing will be to showcase a variety of public/private partnerships and initiatives across the Nation that are successfully inspiring the future science, technology, engineering and math, or STEM workforce.

The Federal Government is investing several billion a year on STEM education. While there may be a federal role, industry, philanthropic organizations, non-profits and local governments have also acknowledged the importance of making investments in STEM. Partnerships and initiatives formed by these investments are very critical to the program. Particularly in this difficult budget climate, we want to highlight some of these efforts and partnerships that are thriving with little or no federal investment. Specifically, the witnesses before us are all involved with tremendously successful STEM-related competitions.

As we can all agree, a well-educated and trained STEM workforce is imperative and key to our future economic prosperity. But we have to capture and hold the attention of our Nation's youth in science and engineering so they will want to pursue these careers, not simply be forced into them simply because we need them. Sitting in a classroom and just memorizing text or taking notes can often drain the enthusiasm from even the most promising student or students. That is why it is important for us to hear from these folks about their creative alternatives to teach and inspire kids, who may not even realize they are learning.

Today, we have witnesses from the corporate, foundation and non-profit worlds showcasing their creative efforts to inspire, moti-

vate and produce our next generation of scientists and engineers with little or no federal funds.

Our Nation has always been number one in science and innovation. In order to maintain this prominence, we have to have an “all hands on deck” attitude toward it. Everyone, in some way, shape or form has to have a role to play in STEM education so that our children and our grandchildren can also experience a vibrant economy with access to good, solid jobs.

I look forward to hearing from each of our witnesses, and I thank you for being here with us today.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH M. HALL

Good morning, I would like to welcome everyone here today for the second in a series of *STEM in Action* hearings. The purpose of this hearing will be to showcase a variety of public/private partnerships and initiatives across the Nation that are successfully inspiring the future Science, Technology, Engineering, and Math (STEM) workforce.

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Our Nation has always been number one in science and innovation; in order to maintain this prominence, we must have an “all hands on deck” attitude. Everyone, in some way, shape, or form has a role to play in STEM education so that our children and grandchildren can also experience a vibrant economy with access to good, solid jobs.

I look forward to hearing from each of our witnesses, and thank you for being here with us today.

Chairman HALL. The Chair now recognizes Mrs. Johnson for her opening statement.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and thank you for all the witnesses that have been invited today.

As I have said so many times before, we truly have a STEM education crisis in this country, and I don't need to remind this audience about how poorly too many of our students perform on tests of math and science proficiency, or how important it is for the future of our country that we do something to address this serious problem. By “we,” I mean all of the stakeholders: federal agencies, states, school districts, businesses, nonprofit organizations, and parents. We must all work together to leverage our respective strengths and resources to tackle this issue. STEM education in this country is truly a complex and grand challenge that no one entity can solve alone.

Today's witnesses represent the private sector. Companies ranging in size from multinational enterprises on down to local businesses are realizing more and more how critical it is to the long-term success of their businesses that they have access to a highly skilled and well-prepared workforce.

While our government is turning the clock back, other countries are pouring resources into building not just their associate and bachelor degree-level workforce, but also their Ph.D.-level research scientists and engineers, providing them a competitive edge we once took for granted. One thing that is interesting to me is that while some of my colleagues in Congress think the Federal Government has no role here, an increasing number of major U.S. companies are turning to partnerships with government, including the Federal Government, to achieve their workforce needs.

President Obama also recognized the importance of partnerships when he launched the Educate to Innovate campaign last year. As part of this campaign, the private sector coordinated with the White House and launched Change the Equation. Change the Equation brought together a coalition of more than a hundred CEOs from some of the Nation's largest companies, all dedicated to working together to improve STEM education in the country. These companies, of course, including Time Warner Cable, Exxon Mobil and Xerox to name a few, have all committed resources to STEM programs across the country. Many of these successful programs are run in partnership with federal agencies such as NASA and the National Science Foundation. Among the new public-private partnerships announced as part of the President's Educate to Innovate campaign was the National STEM Video Game Challenge, and I look forward to hearing from Mr. Gallagher about the National STEM Video Game Challenge and how he and his colleagues worked with the White House and other partners to make the competition a success.

Competitions and challenges have tremendous potential to both inspire students and teach them STEM knowledge and skills in ways that the traditional classroom teaching cannot. However, we also know from a recent National Academies report on informal STEM learning, and a hearing we held on that same topic in the 111th Congress, that there remains a big gap in understanding how students learn outside the classroom and to what extent informal experiences influence their long-term interest and success in STEM. Most of what we know or think we know is based on anecdotes or attitudinal surveys. Here there is a clear and unique federal role in developing the necessary body of knowledge.

The National Science Foundation is the leading entity in this country for funding research on STEM learning in both formal and informal environments, including competitions. The results of NSF-funded research over many decades have helped and will continue to help to ensure that education practitioners are incorporating effective practices with measurable results. At the end of the day, what counts is whether the STEM programs we are hearing about are achieving their desired results, not how much money we are spending on them or even how many students they touch.

We are all in this together. I commend the witnesses and your colleagues in the private sector for your efforts in helping to im-

prove STEM education in this country. But I would also like to repeat a request that I made at our last STEM hearing, that we not continue to ignore the unique and important role of the Federal Government in improving STEM education in this country.

Mr. Hall, I thank you very much for this hearing and I yield back.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you Chairman Hall, and thank you to all of our witness for being here today. As I've said so many times before, we truly have a STEM education crisis in this country. I don't need to remind this audience about how poorly too many of our students perform on tests of math and science proficiency, or how important it is to the future of our country that we do something to address this serious problem. By "we," I mean all of the stakeholders: Federal agencies, States, school districts, businesses, non-profit organizations, and parents. We must all work together to leverage our respective strengths and resources to tackle this issue. STEM education in this country is truly a complex and grand challenge that no one entity can solve alone.

Today's witnesses represent the private sector. Companies ranging in size from multinational enterprises on down to local businesses are realizing more and more how critical it is to the long-term success of their businesses that they have access to a highly skilled and well-prepared workforce. While our own government is turning back the clock, other countries are pouring resources into building not just their associate and bachelor degree level workforce, but also their Ph.D. level research scientists and engineers, providing them a competitive edge we once took for granted. One thing that's interesting to me is that while some of my colleagues in Congress think the federal government has no role here, an increasing number of major U.S. companies are turning to partnerships with government, including the federal government, to achieve their workforce needs.

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Chairman HALL. I thank the gentlelady from Texas. She yields back.

If there are Members who wish to submit additional opening statements, statements can be added to the record at this point or a little bit later.

At this time I want to begin to introduce our first panel of witnesses. Our first witness is Mr. Tony Norman, President and CEO of Innovation First International, which Mr. Norman founded in 1999. I am proud to say he is a constituent from my district. One of the interesting things about Tony and Innovation First is the commitment they make to the local community of Greenville, Texas. If you visit their plant, you will see local high school students working on projects and interning in the facility to learn more about engineering and technology, and many of these students have gone on to college to study engineering at Tony's suggestion and his behest, and he truly gives back to his hometown and wants to build lasting success for Greenville and for the Nation, and he is an international operator. I find him sometimes in China, sometimes he is somewhere in Europe, and he is kind of hard to find, but we are very fortunate to have him here today because he is one of the busiest men I know. I had the pleasure of speaking at one of his operations in Orlando, I think there were five or 10,000 folks there, and Tony told me I had 3 minutes to speak, and I got into my speech about a minute and a half and he was doing what my wife always does to me when I am making speeches. He was doing like this, and I think he meant for me to stop, and I later learned that with all the great technology in the bosom of the United States of America right there in the crowd, we had a malfunction of some type, I don't know what it was, but it was a great meeting with a lot of young kids that were there. Those who won were happy. Those who lost were determined to come back and win next year. But it really gives you a new perspective on the country when you see these youngsters that folks like these three people are here testifying for us today bragged on, supported and helped. I look forward to it.

Our second witness is Mrs. Nancy Conrad, and I have known her husband for many years, and at this time I yield to Mr. Rohrabacher of California to introduce Mrs. Conrad. I really wanted to introduce her but Rohrabacher outranks me, and he got it. I really need his vote every now and then. I am even going out to his home Sunday to make a speech for him Sunday at noon and I am going to fly back Sunday night. That is how much I think of Mr. Rohrabacher. So you ought to be helping me a little more than you are. I recognize Mr. Rohrabacher to introduce Mrs. Conrad.

Mr. ROHRABACHER. You got it, Mr. Chairman. You got it.

It is my personal and professional pleasure to introduce Nancy Conrad to Members of the Committee and all of you. She has been a close friend for many years. I was a close friend of course when Pete was alive and I was a young member of this Committee, and he was a very inspiring human being and we know all of his exploits in terms of Apollo 12 and the third man on the moon, but when Pete was taken from us, Nancy picked up the challenge of making sure that America and the world keeps moving outward and realized that perhaps the most important thing we have to do

to achieve the goal of keeping America the number one space power to keeping humankind in the ascension into space was the fact that we have to have our young people trained and motivated to be able to participate in this great task that humankind has, which is to deliver our species beyond where we are at and into the heavens and into the universe.

So with this, after Pete's passing, Nancy started the Spirit of Innovation Awards as part of the Pete Conrad Foundation. She herself of course was an English teacher and very involved in education and has been well-known throughout the world as an advocate for science education and science as part of a young person's curriculum, but today she is going to be, I believe, talking to us about the Spirit of Innovation Award, and I believe she deserves an award for innovation in her approach, and I think that it is—I am looking forward to hearing all about it and I know that it should inspire members of this Committee but also we should be grateful, and the students who are participating in this should be grateful for something that excites young people about science, engineering, mathematics, things that will carry humankind to our next step. So we welcome Nancy Conrad.

Chairman HALL. Thank you, Mr. Rohrabacher.

Nancy, we do admire and respect you and remember the service of you and your husband.

Reclaiming my time, thank you, Mr. Rohrabacher, for the good introduction. Our third witness and final witness is Mr. Michael D. Gallagher, President and CEO of the Entertainment Software Association. Mr. Gallagher also leads the ESA'S partnership with the Congressional Caucus for Competitiveness and Entertainment Technology. Previously, he was the Assistant Secretary for Communications and Information at the U.S. Department of Commerce. I had the pleasure of visiting with him some time ago, and we thank all of you because we know it is trouble, expensive. You have to have time to get ready for this testimony. You had to come here from somewhere and you have to eat while you are here and stay somewhere while you are here. You give a lot to be here and we appreciate you, and we really ought to have these seats full, but as I explained to you, we are in kind of a desperate time up here. We are trying to survive a lot of bad situations that is happening to our country, and we thank you for giving this time is what I am trying to say and not saying it too well.

But as our witnesses should know and probably do know, spoken testimony is limited to five minutes. We are not going to hit the gavel on you if you go over five minutes but as close to five minutes as you can stay, the more likely you are to win the drawing that we may have when this is over. The members of the commerce—Committee will have five minutes each to ask questions. We will try to hold them to that same.

So I recognize our first witness, Mr. Norman, for five minutes, but you won't be held to that.

STATEMENT OF MR. TONY NORMAN, PRESIDENT AND CEO OF INNOVATION FIRST INTERNATIONAL, INC.

Mr. NORMAN. Thank you, Congressman, and thank you, Committee members, for inviting me here.

I have 20 years of experience in educational robotics, and it basically started back when I worked as an electrical engineer at one of the largest defense contractors for this country. We spent a lot of time inspiring kids and youth to take careers in STEM education, and in fact, one of the accomplishments we actually had was get to bring those kids here to the White House after winning a championship. Because of that experience that we kept seeing how these kids kept growing in their inspiration, myself and one of the other team members decided you know what, let us believe our own medicine here and let us start our own company.

So we started our own company, as Congressman Hall said, in Greenville, Texas, and it is really a great high-growth story. In the last three years, we have created 150 jobs. We now have offices worldwide, and just to kind of give you a quick review of a few of them, one of our divisions, Rack Solutions, builds racking equipment for data centers and actually a few products for the U.S. military, and the exciting part is, in this very highly competitive market we are in, we are actually able to compete with U.S. manufacturing, so we felt that was a great accomplishment.

We actually do know kids. In fact, we know kids so well that one of our most successful companies is creating toys. This toy division was actually inspiration as well from the robotics program we have been participating with, which I will tell you about in a few minutes, and our largest accomplishment to date was last year we just received the Specialty Toy of the Year in the toy industry, so that was pretty exciting for us.

The VEX Robotics design system is basically from our third division. It was created as an educational robotics kit, and it is really designed for an open-ended problem solving. It is not just a set of instructions you actually go through but really it is more than just a kit. It is the only platform with significant penetration in the daytime classroom and extracurricular competitions, so that is extremely important and I hope to emphasize that a little bit later. We are showing up everywhere in the classroom, and I am just curious if you guys could find the VEX robot in this picture.

Project Lead the Way is one of our partners. We are partnered with many 501(c)(3)'s. Project Lead the Way is the largest daytime curricular program in the United States and they endorse the platform and also endorse our robotics competition as well as their competition. Technology Student Association, another partner of ours in the space, they are actually a co-curricular program where they are in the classroom and have competitions out of the classroom. They run about 200 competitions, but for robotics, they actually came to us and joined the VEX Robotics competition.

Another 501(c)(3), BEST, Boosting Engineering, Science and Technology, is another inspiring. This one is free to all the schools that participate and all of their electronics and sensors are basically from the VEX Robotics system because we have the leading platform in the educational space.

So we come to the actual VEX Robotics competition itself before basically seeing the partners we have with the equipment we provided. This last year where Congressman Hall was there, we were at Disney World. These are some of our corporate sponsors that we are pretty proud of.

VEX is the largest middle school and high school robotics competition in the world. This is kind of a comparison of where we compare to some of our other programs that are out there as well.

Basically I want to kind of take you through and show you a few images from the competition. It is really hard to describe the excitement and the feeling you get there and the enthusiasms that the kids actually feel and the scale of it. Basically, it takes a lot of donations from corporate sponsors to actually make an event of this size actually happen, but it affects the students in such a way that we are getting to kids that never would be interested in science and technology, and it is basically helping build that workforce for the future. You can see the scale of this event. Once again, this was our main arena for the finals and the pit area, and the previous slide shows you just the enormous—it is like a huge trade show. Over 600 teams were at this event. And of course the excitement, getting them ready, getting them excited about science and technology and putting these corporations on display so as a corporation donates, it is not just a blind donation. They are putting their company on display. So when it comes to recruiting these kids and building that workforce for the future, they are actually there ready and the students know who they are, and in fact, they want to actually go to that company.

Recently, we have done quite a bit with the Boy Scouts of America. We helped them create their first robotics merit badge. We had a big showing at their jamboree and it was extremely exciting. The same thing up here at the Mall in D.C.

I am just going to end here with, we really plan to continue to forge a relationship with more nonprofits, with industry, with leaders in the corporate world, and really help try to build and inspire that workforce for the future. Thank you.

[The prepared statement of Mr. Norman follows:]

PREPARED STATEMENT OF MR. TONY NORMAN, PRESIDENT AND CEO OF INNOVATION FIRST INTERNATIONAL, INC.

VEX ROBOTICS: INSPIRING AND PREPARING STUDENTS FOR STEM CAREERS

Introduction ...

Good morning Committee Members and those joining us here today. My name is Tony Norman and I am the co-founder and chief executive officer of Innovation First International and VEX Robotics, Inc. I want to thank Congressman Hall and the Committee on Science, Space, and Technology for inviting me to speak with you here today about how VEX Robotics is inspiring and preparing students for STEM careers in the 21st century workforce. At the start of my career I worked for a large defense contractor in Greenville, TX, as an electrical engineer, and designing robots for competition is one of the things I'm most passionate about. Over the past 20 years I have had the honor of mentoring, volunteering and supporting local middle and high school robotics teams, which even resulted in a national championship that led to an invitation to the White House and personal recognition by then President Bill Clinton. It was a combination of all of these life experiences that inspired me to start my own business, Innovation First International, which is the parent company to RackSolutions Inc., HEXBUG Micro Robotic Creatures, and VEX Robotics, Inc. Over the past decade, I've been focused on getting VEX Robotics into teachers' classrooms and afterschool programs around the nation, and the world, which is what I'm here to speak to you about today.

The world needs today's students to become tomorrow's scientists, engineers, and problem solving leaders. The constant breakthroughs in chemistry, medicine, materials and physics reveal a new set of challenges and create an even greater opportunity for solving problems through technology. Finding solutions to these problems

could help save our country and the world, and it will be the technology problem solvers of our future who will become the people who make it possible.

This underscores the dramatic challenge we face today as a nation: there are not enough high school graduates taking an interest in the fields of Science, Technology, Engineering and Math (STEM) and feel prepared enough to major in these related disciplines going into college. This does not reflect a lack of capacity for new students on the part of technical schools and universities, but a lack of interested and qualified applicants.

Recognizing this dilemma, scores of private corporations and non-profit organizations, including Innovation First International, VEX Robotics, Inc. and the Robotics, Education and Competition (REC) Foundation, are creating non-traditional programs and partnerships designed to attract and encourage students to embrace STEM education through hands-on learning in the classroom and through after-school competition, using robotics as the driving catalyst.

At VEX Robotics, we have found robotics to be such a powerful platform, capable of attracting and holding the attention of today's multi-tasking, connected youths. VEX Robotics integrates education and technology, and gets entire classrooms of students to have a hands-on experience and understanding for what engineering can really be like. It's more than just a visual exercise of taking something from a textbook and memorizing it. VEX Robotics gives students a chance to create and design a robot, and then actually turn that around and build it into something physical, something real, that's a very visceral experience that most young people don't get nowadays. To have students go through this process, they get to see and understand what happens when you create your own device, and that's an amazing and character building experience that gets them really excited and in turn gets us excited about their future with us.

With VEX Robotics, students get energized about "learning by doing," they get comfortable with the "trial and error" process, and they are constantly involved in applying their knowledge and putting it into action—which becomes a process that sticks with them over the years. The VEX Robotics Competition strongly appeals to this intensely competitive generation and represents the perfect storm of applied physics, mathematics, computer programming, digital prototyping and design, integrated problem solving, teamwork and thought leadership.

Defining the VEX Robotics Design System & the VEX Robotics Competition

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The VEX Robotics Design System, recognized with the 2006 Best of Innovations Award at the Consumer Electronics Show, was designed to be an affordable, accessible and scalable platform used to teach STEM education worldwide. The Vex Robotics Design System includes everything young inventors need to design and construct radio-controlled robotics devices that lift, throw, race and expand the boundaries of experimental intelligence. The VEX Robotics Design System comes with various sensors, electric motors, a servo, wheels, gears, and structural parts. Additional accessories are available separately. With VEX Robotics, young people have a fun, non-traditional way to learn about STEM, and by working together to create robots that perform exciting challenges, they also gain valuable problem-solving and team-building skills.

The VEX Robotics Competition utilizes the VEX Robotics Design System. Each season, teams build and program a robot to complete that season's game, which is revealed each year at the VEX Robotics World Championship. The competition is played on a 12'x12' square field. Two alliances—one "red" and one "blue"—composed of two teams each, compete in each match which consists of a twenty-second autonomous period followed by two minutes of driver-controlled play. The object of the game is to attain a higher score than your opponent alliance by scoring game elements in designated goals. Teams have the opportunity of attending local, regional, state, national and international competitions.

The Effects of the VEX Robotics Classroom & Afterschool Competition ...

When developing VEX Robotics, we wanted to create a platform that would enable kids to have fun while learning at the same time. We also understood that the program must be affordable to become sustainable so that all schools, public and private, could adopt the platform. With VEX, kids learn critical problem solving and computer skills, they get experience with hands on building and competition, they learn how to become leaders and work as a team, they gain exposure to potential future employers, and they get inspired to pursue higher education and eventually a career in the fields of STEM.

Like the Orion Nebula star system, educational robotics is still in its infancy, but it is steadily expanding. Robotics has tremendous educational potential as it sits at

the intersection of STEM subjects. The analogy that we like to use for robotics is the Flintstones vitamin: Teachers like it because of its educational ingredients, while kids like it because it's fun.

VEX Robotics was designed with the classroom and after-school competition in mind. It taps kids' interest in computers, hands on building, and the innate human desire to compete, and provides them with a very visceral experience that helps reinforce what they learn in school. By participating on a VEX Robotics Competition team, students develop some of the critical skills necessary for the workforce, including problem solving, teamwork, creativity and leadership.

VEX Robotics taps teachers' interest by providing them with strong, standards-based accredited curriculum, higher levels of engagement amongst students, enhanced professional development, enjoyment and oftentimes rewarding stipends.

Overall, VEX Robotics motivates more students to explore STEM education and consider careers in STEM related fields by making STEM fun. It increases engagement in STEM subjects from middle school through college. It prepares students for secondary education, it better enables us as a nation to meet workforce demands, it increases diversity among the workforce and it strengthens our long-term competitiveness as a nation.

Statistics show that we need to encourage more minorities to explore engineering opportunities. We need more affordable and widespread programs. And we need more teachers and mentors to provide leadership among underrepresented minorities. For example, more than 1,000 inner city students from Baltimore City school districts have benefited from their involvement in VEX Robotics over the past two years. Specifically, pre and post test scores indicate significant gains in science and math test scores as well as class attendance amongst students who were exposed to VEX Robotics versus students not exposed to the platform.

Students with a previously undiscovered aptitude for STEM curriculum are beginning to flourish in growing numbers due to the growing efforts of schools, volunteer organizations, corporations, and government entities that are working to integrate robotics platforms such as the VEX Robotics Competition, into the fabric of America's middle and high school education system.

It's meetings like this one today that provide encouragement and show how many different leaders and industry entities are focused on this critical STEM problem. As documented by James Surowiecki in his best seller *The Wisdom of Crowds*, the best solutions emerge when a broad and diverse sample of individuals work on a solution to a problem.

The Importance of VEX in the Classroom & As an After-School Competition

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VEX Robotics, Inc., is ten years in development, and a leader in designing and supplying the most advanced technology to the largest number of middle and high school classrooms and educational robotics competitions worldwide. VEX was designed for education, architected for competition, and cost engineered for scalability. We are backed by industry leaders and VEX Robotics is the apparatus of choice for multiple curriculum developers. Our vision has been to offer the most comprehensive, cost-effective learning platform that can be scaled for Elementary to College students and even further into the workforce of the 21st century.

Meanwhile, the VEX Robotics Competition, created by VEX Robotics, Inc. and operated by the Robotics Education and Competition (REC) Foundation, is a program that inspires and prepares hundreds of thousands of middle school, high school and university students worldwide to pursue STEM-related education and career paths.

Our vision and goal is to motivate, excite and prepare students to go to college and pursue STEM education to prepare them to enter the workforce specializing in a STEM focused career. Most robotics programs that exist today end at high school, are costly and solely focused on after-school competition, and rely heavily on engineers from industry partners to volunteer their time. VEX Robotics addresses this issue by dramatically lowering the cost of participation for schools and students, by extending beyond high school through to college, and by involving higher participation and support from parents and teachers as mentors—because we want robotics to motivate students to go beyond high school—we want robotics to show students that they can all become top STEM professionals.

Why is this important to us? For years now, after school robotics competition programs have focused on inspiring students to pursue STEM careers. It is no longer enough to just inspire kids with robotics through after-school competitions, which is what differentiates the VEX Robotics platform from any other robotics platform on the market. *VEX Robotics is the only middle and high school robotics platform with significant penetration in both the daytime classroom instruction and extra-curricular competitions.*

By exposing our youth to VEX Robotics in the classroom as well as after-school with the VEX Robotics Competition, more students have better access to STEM training and mentoring in the field, making them better able to compete and emerge as leaders in the future global economy. VEX Robotics provides students with a “real world” example of the skills they observe and learn in other classrooms and allows them to see relevant applications of their knowledge in real life situations. They get exposure to companies that could be their future employers, thanks to our valued partnerships. It’s the perfect model for the workplace.

VEX Robotics kits range from \$299 to \$849, and the daytime curriculum ranges from \$199 to \$1,295. With VEX Robotics, you can put entire classrooms of students’ hands physically on robots, working in groups of one, two and three. Our custom system is of the highest standard and includes over 700 items to choose from. We provide Classroom lab kits as easy answers for teachers who want to know everything they need to start a program in the classroom. In order to continue to ensure the growth of VEX Robotics, we are committed to keeping costs low and will continue to improve and innovate when it comes to the software and hardware we offer.

VEX Robotics Partnerships ...

The VEX Robotics Competition continues to experience explosive growth year over year, with more than 4,000 teams from 20 countries playing in over 250 tournaments worldwide. We would not be able to prepare the next generation of STEM inspired minds through robotics education, without the support our valued partners.

Our partnerships include the REC Foundation, Autodesk, NASA, BEST, Project Lead The Way, Northrop Grumman, Technology Student Association (TSA), SkillsUSA, EMC Corporation, Carnegie Mellon University, Intelitek, Microchip, Innovation First International, the United States Coast Guard Academy, iD Tech Camps, Automation Direct and the CREATE Foundation.

Daytime Classroom Curriculum & Competition Partners:

- **VEX + Project Lead the Way (PLTW):** More than 400,000 students in more than 4,200 schools in all 50 states and the District of Columbia are taking PLTW courses in the 2011–12 school year. In addition, PLTW has trained more than 18,500 teachers to instruct its engaging, rigorous STEM education curriculum. PLTW is the nation’s largest co-curricular program in the U.S. and its partnership with VEX Robotics gives current and future PLTW schools new, exciting and cutting-edge opportunities both inside and outside the classroom. Students use VEX Robotics equipment during the school day, and they also have the ability to take part in the after-school VEX Robotics Competition. These competitions allow students to apply their robotics knowledge from the classroom in a unique, problem-solving environment.
- **VEX + Technology Student Association (TSA):** TSA serves more than 150,000 students at 2,000 schools in 48 states, and is a national non-profit organization for middle and high school students with a strong interest in technology. The TSA–VEX Robotics Competition provides students with a hands-on, co-curricular competition for learning STEM and complements the existing technology-related competitions offered by TSA. TSA–VEX Robotics teams compete either at events held at TSA state conferences or at other official VEX Robotics Competition tournaments. The season culminates with a championship event at the National TSA Conference. Specific details on events are available at RobotEvents.com.
- **VEX + SkillsUSA:** More than 300,000 students and advisors join SkillsUSA annually, organized into more than 17,000 sections and 54 state and territorial associations. SkillsUSA is a partnership of students, teachers and industry working together to ensure America has a skilled workforce. SkillsUSA is a national nonprofit organization serving teachers and high school and college students who are preparing for careers in trade, technical and skilled service occupations, including health occupations. SkillsUSA has partnered with VEX Robotics for their Mobile Robotics Competition, which utilizes VEX Robotics hardware.
- **VEX + Da Vinci Minds:** DaVinci Minds has implemented VEX Robotics in core classroom curriculum spanning 11 school districts in Texas, where students work continuously throughout the year to prepare to become tomorrow’s innovators. DaVinci Minds offers products and services for middle schools, high schools, community colleges and universities in a broad array of programs that center on the intersection of technology, education and workforce development. Da Vinci Minds chose to partner with VEX Robotics due to its price, reliability

and flexibility. Da Vinci Minds has implemented VEX Robotics in high school math classes in about 11 school districts in Texas and is expanding.

- **VEX + Autodesk:** Autodesk is a curriculum partner, and also supports the VEX Robotics Competition. The Autodesk VEX Robotics Curriculum is a comprehensive robotics program developed for secondary schools by experienced educators and technical experts in partnership with Autodesk and VEX Robotics, Inc. The curriculum meets U.S. academic national standards and helps students master the fundamentals of robotics and the engineering design process while learning to use industry-leading Autodesk Inventor design software and the leading classroom robotics solution, the VEX Robotics Design System. The robotics curriculum actively engages students in real-life design projects and helps them to develop science, technology, engineering, and math skills in a challenging and exciting context. By integrating Autodesk's VEX Robotics Curriculum into your classroom, your students will see the dynamic connections between science, math, and technology, and they will be better prepared for college and careers in engineering, design, and robotics.
- **VEX + Intelitek:** Intelitek is a curriculum and software provider for VEX Robotics. Intelitek's Robotics Engineering Curriculum is a two-year robotics program for applied science, technology, engineering and mathematics. This curriculum maps to national STEM Standards and custom-maps to any local standard. REC was built specifically for the VEX Design System and includes lessons with hands-on experience for robotics, engineering, and programming. REC provides a strong blend of mechanical principles and STEM activities with sensor use and programming. Activities are leveled for multiple skill levels and each semester includes a teacher guide to provide answers and sample programs.
- **VEX + Carnegie Mellon University (CMU):** CMU is a curriculum provider for VEX Robotics. The CMU VEX curriculum is broken into six major sections: safety, project management, planning your project, robotic lessons, programming lessons, and engineering activities. The curriculum is designed to support teachers using the starter kit and also teachers interested in taking advantage of VEX's advanced features like: advanced programming, controlling motors using PWMs and relays, pneumatics, homebrew sensors. Reorganized units make for ease of navigation. Units provide step-by-step instruction and open-ended challenges where appropriate. Quizzes are incorporated with the hands-on learning experience to aid in retention. Key mechanical engineering concepts are coupled with the ability to study programming and sensor use in-depth if desired.

Extracurricular VEX Robotics Competition Partners:

- **VEX Robotics + REC Foundation:** The REC Foundation, a 501(c) (3) non-profit organization, partners with VEX Robotics, Inc. to organize and operate the VEX Robotics Competition worldwide. The REC Foundation supports robotics and technology events and programs that aim to inspire and motivate students to advance in STEM education. In addition to supporting competitions for some of the world's leading robotics platforms and organizations including VEX, TSA and BEST, the foundation also provides program support and workshops focused on technology and professional development for educators—including the RobotEvents.com community portal website which helps promote multiple high quality programs and provides online registration and event pages for hundreds of events around the world.
- **VEX + BEST:** VEX Robotics is a proud supplier to the BEST Robotics Competition. BEST Robotics, a non-profit organization reaches roughly 750 schools in 14 states resulting in roughly 11,000 students currently active in the program. BEST partners with universities and other companies including VEX Robotics, to offer robotics kits to middle and high school students at zero costs to schools. BEST uses the VEX Cortex Microcontroller, VEXnet Joystick and other accessories, which we provide to them at a heavily discounted rate. The REC Foundation and VEX Robotics are also proud to host BEST's annual national championship competition.
- **VEX + BSA:** VEX Robotics is proud to be a partner with the Boy Scouts of America on the Robotics Merit Badge. Boy Scouts now have the opportunity to earn a merit badge while learning about science, technology, engineering and mathematics. Not only did we help in developing the Robotics Merit Badge Requirements, but BSA demonstrated the new Robotics Merit Badge as a workshop at the VEX Robotics World Championship, and more than 20 of the first Scouts to receive the Robotics Merit Badge were in attendance.

- **Additional Corporate Support:** Corporations are throwing their support behind STEM development programs like VEX Robotics in order to ensure there's an adequate talent pool of engineers to fill open positions in the future. Northrop Grumman, Autodesk, EMC, BAE Systems, Baxter, Boeing, Boston Scientific, Chrysler, Dassault Systems, Delphi, Google, GM, Texas Instruments, Timken, Xerox and 3M are just a few of the sponsors of national robotics competitions in the U.S.
- **Parent / Teacher Involvement:** VEX Robotics Competitions would not be what they are today without the support and commitment we receive from parents and teachers. VEX Robotics sees significantly higher participation and support from teachers given the daytime classroom integration through curricula materials and scale of the design & build process that lends itself to a wider participation by students. Many parents and teachers involved with VEX Robotics describe themselves as coaches, mentors, non-technical mentors, or a combination of two or more of these roles. A coach is defined as someone who helps students with design, building, and planning related to competitions; a mentor is defined as someone who shares his or her specific expertise in engineering, robotics, computer programming, and/or technological areas who serve as advisors to teams; non-technical mentors are defined as someone who helps coordinate travel, chaperones students, or does event planning or other similar activities.

Preparing Students for the Workforce ...

Through their participation in the VEX Robotics Competition and the work they do within their teams, students pick-up many of the academic and life skills necessary to excelling in the workforce. In fact, at VEX Robotics, Inc., our high school and college internships are extended to those who excel at the VEX Robotics Competition. Many of our full time employees were initially discovered through their leadership and participation in competitive robotics programs.

According to a study conducted by the Center for Education Integrating Science, Math and Technology at the Georgia Institute of Technology in June of 2011, student and mentors overwhelmingly reported positive student effects from participating in VEX Robotics Competitions, in areas including:

- **Teamwork**– By participating in the VEX Robotics Competition, students develop critical teamwork skills, specifically referencing a growth in taking individual responsibility for one's part on a team, solving difficult problems with teammates, and being a good teammate.
- **Interest in STEM**– By participating in the VEX Robotics Competition students develop an interest in STEM education and career opportunities, something that was previously lacking. VRC participation positively impacts students' interest in STEM, creating a greater interest and desire to learn more about robotics, engineering, computer science, design and STEM career opportunities in high school, college and beyond.
- **21st century skills**– The VEX Robotics Competition positively impacts students in developing their 21st century skills, specifically in terms of accepting and providing critical feedback, goal setting, using time effectively, collaboration, self-direction and motivation, and learning from their failures. Many of the teamwork forming dynamics that they go through are parallel to those they will encounter in the workforce.
- **Self-efficacy**– By participating in the VEX Robotics Competition, middle school, high school and university students' confidence increases, related to school achievement, doing well in STEM coursework, succeeding in a STEM career, asking questions, presenting ideas, fundraising and communicating.
- **Sportsmanship**– Participating in VEX Robotics Competitions helps students grow their character in terms of sportsmanship, learning how to be honest and fair in competitive situations, and learning how to value each team member's contributions.

In addition to improving retention of key STEM principles as a result of participating in the VEX Robotics Competition, there is also a correlation between participating in VEX Robotics Competitions and performing and scoring well in STEM classes.

How we as a Nation Can Spark a Greater Student Interest in STEM Education ...

What we need to do is clear—we need to democratize student robotics participation. We need to engage, inspire and prepare students to pursue science, engineer-

ing and technology in higher education and as a profession—and robotics serves as the perfect catalyst. Robotics makes STEM relevant to students, and relevancy drives engagement, inspiration and action. VEX Robotics was designed for education, architected for competition, and cost engineered for scalability. Our goal is to continue to forge the necessary relationships with non-profit organizations and industry to fuel tomorrow's workforce by making VEX Robotics accessible to everyone, and integrating this hands-on learning tool to as many schools as possible, to as many students as possible, in as many cities, states and countries as possible.

Corporations have the most to gain from investing in programs like VEX Robotics and preparing students for the workforce. If every corporation were to allocate some of the resources that they use on recruiting efforts and community involvement, and reinvest those funds into programs like VEX Robotics, they would gain enhanced exposure for their company, they would be giving back to their community, and most importantly, by investing in these kids at an early age, corporations would gain immediate access to some of the best and brightest minds from which to pull talent when it comes to workforce development. Supporting robotics creates a life-long learner that is actively involved in building their 21st century skills in addition to developing their expertise in the fields of STEM, which are qualities that all good employers need and when they look to bring a talented new hire on board.

Thank you for the opportunity to speak to you today about VEX Robotics and the VEX Robotics Competition, and how we are inspiring and preparing the science and engineering workforce of tomorrow.

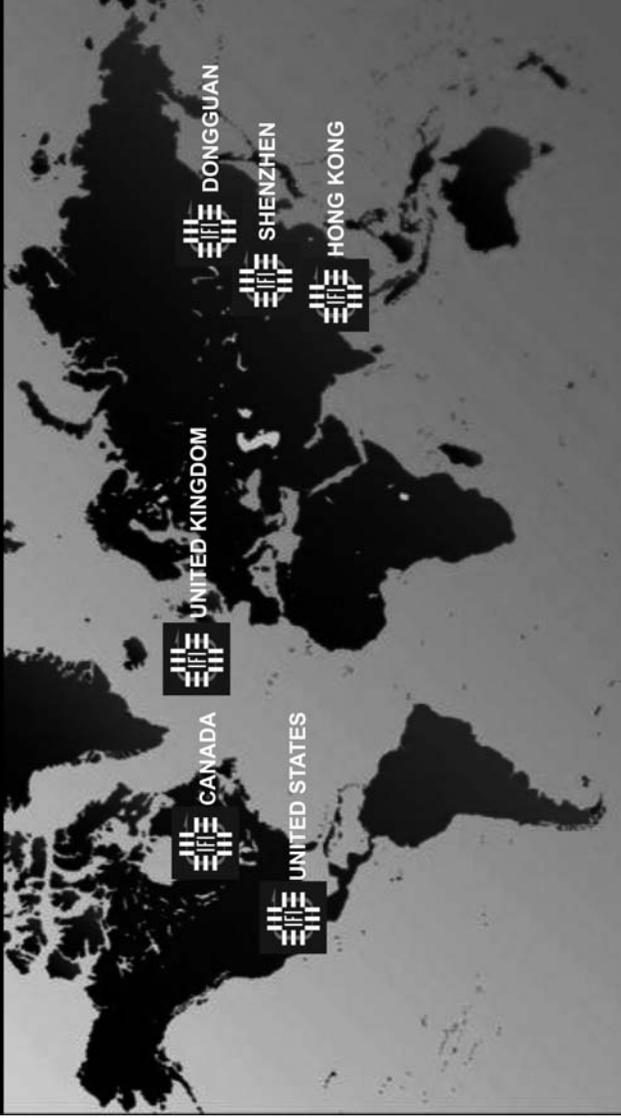
[The powerpoint slides accompanying Mr. Norman's statement follows:]

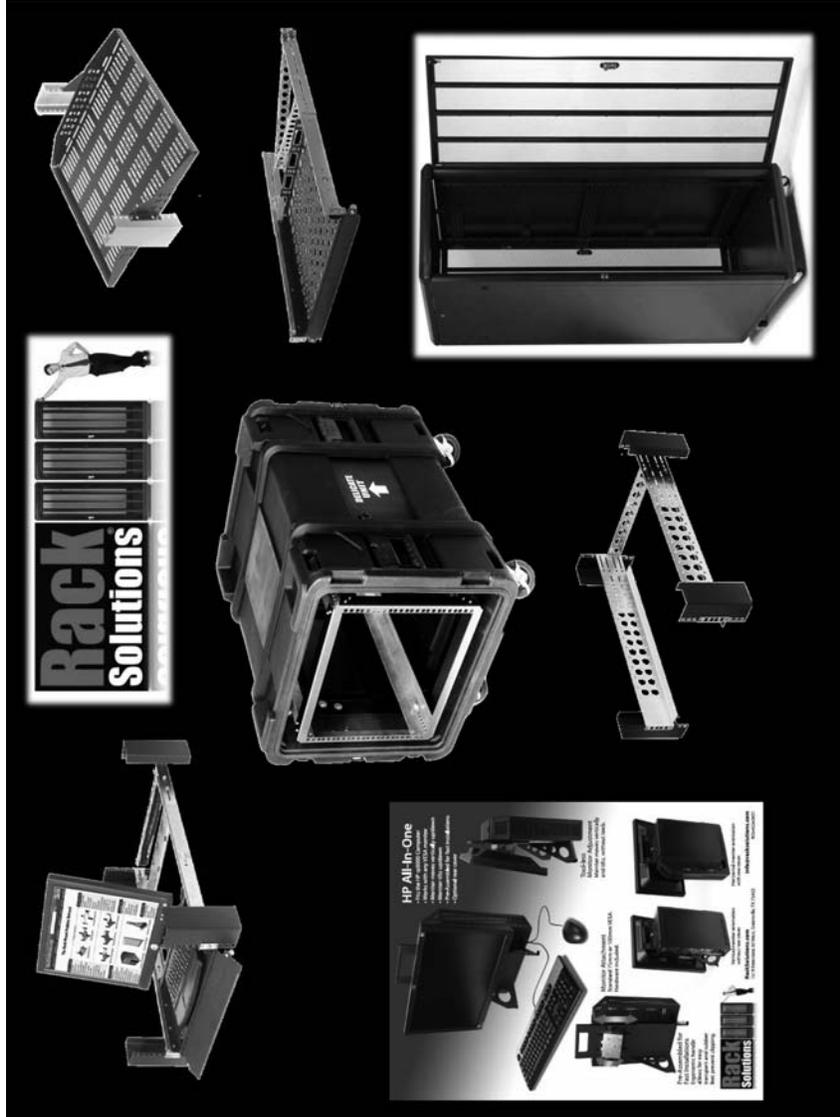


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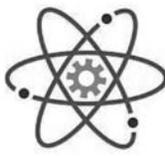




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VEX Robotics Competition

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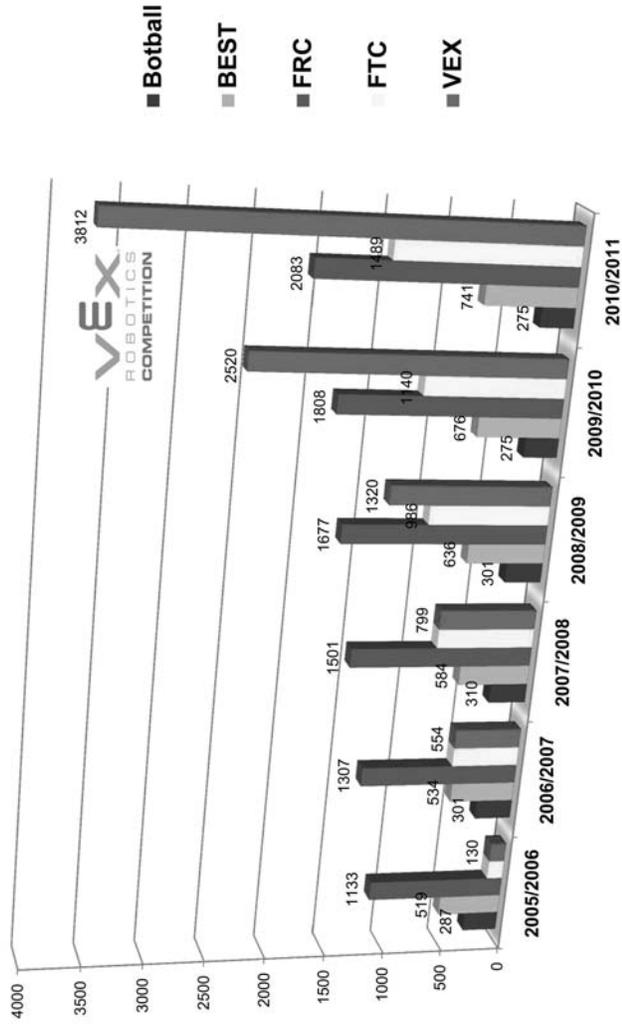
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VEX Robotics Competition





VEX Robotics Competition

VEX Robotics Competition



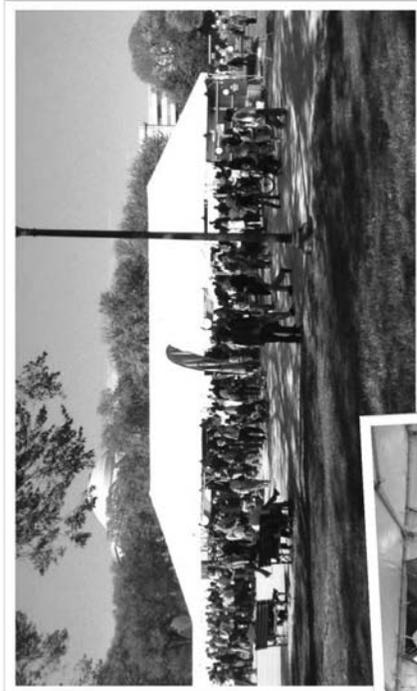
VEX Robotics Competition



VEX Robotics Competition







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Chairman HALL. I thank you very much.
I now recognize Mr. Gallagher for five minutes for his testimony—I mean Mrs. Conrad for her testimony. Same five minutes.

**STATEMENT OF MRS. NANCY CONRAD, CHAIRMAN AND
FOUNDER OF THE CONRAD FOUNDATION**

Mrs. CONRAD. Mr. Chairman and Members of the Committee, thank you for this opportunity to discuss our participation in solving America's STEM education crisis, or as I call it, the edudemic.

In a recent article in the New York Times, Tom Friedman said, "If we want more jobs, we need to create more Steve Jobs." Steve Jobs took his knowledge of STEM and created a phenomenon that impacts our lives in ways we can't even currently quantify. Bill Gates, Larry Page, Sergey Brin, Mark Zuckerberg, they have done the same thing. They too have taken their knowledge of STEM, combined it with innovation and entrepreneurship and created world-changing breakthroughs which have forever altered the way knowledge is valued, shared and utilized.

The hallmark of America's culture is innovation and entrepreneurship. It is how we got to the moon. It is how companies like Apple, Facebook and Google were formed. It is how our country will continue to explore the universe, discover cures for disease and become good stewards of the world we share with our global neighbors.

If we are to reinforce America's economic stability and ignite our Nation's passion for STEM education, we need to embrace an academic plan that focuses on the relevance of the knowledge we share with our students. We all know memorizing facts to pass a test isn't doing the job.

The Spirit of Innovation Awards program, the flagship of the Conrad Foundation, is rooted in this concept. Our program challenges teams of high school students to create solutions to real-world problems using STEM-based principles and practices supported by innovative thinking and entrepreneurial skills. We are energizing the next generation of entrepreneurs and innovators needed to sustain our economy. Students who participate in the program come from all socioeconomic levels. Our student entries come from across the United States, from the Navajo Nation to Thomas Jefferson High School, ranked the number one high school in the country. We are pleased that one-third of our students are girls and one-third are inner-city students.

The Spirit of Innovation Awards program operates year-round through our online community and our annual event. Our teams are supported in their journey by their teachers and our community of mentors and experts who together endeavor to help these students hone their own design skills as they create the innovative products. From aerospace and energy to cybersecurity and nutrition, no question is too large for these students.

Finalist teams are selected to participate in our Innovation Summit at NASA Ames Research Center where they meet world-renowned scientists and entrepreneurs from industry, government, academia and venture capital. The students present their ideas and are coached and mentored by these experts with the intent of bringing the students' product to the marketplace. Winners are

awarded a grant to continue the development of their product and selected teams are invited into our portal where we assist them in patenting their product if it is needed and then licensing their intellectual property. This is a way for them to monetize their ideas without dropping out of school to create companies. We are four years young and already seeing amazing results. Let me provide you with a few examples.

Winning teams of the past have addressed nutrition needs for astronauts, developed light electric cars, and a smartphone biomedical application for monitoring heart rates. Daniel and Isaac from Katy, Texas, have two patents on an offshore geothermal energy-generating system and they have been archived into the Kennedy Presidential Library. Michaela and Shannon from Battle Creek, Michigan, created a nutrition bar that meets NASA's standards for nutrition and stability in microgravity. They have been honored at the White House and recently their product was flown above STS 134. This is where real science gets real.

Our program and the media coverage our students receive shines a spotlight on how cool science can be and how interesting and challenging the careers in STEM can be. We are not just growing a program, we are driving a movement. We have turned geeks into rock stars.

Our competition is open to all who wish to participate free of charge. We are supported in partnership with Lockheed Martin, PepsiCo and Kraft Foods. We receive program support from NASA, the American Institute of Aeronautics and Astronautics, the American Society for Nutrition, the William James Foundation, the National Institute of Health, Sigma Xi, museums and science centers, Popular Science magazine, SpaceRef and STEM Connector.

This year we are also taking advantage of a unique opportunity to provide our winning teams of students with a global scientific experience. In partnership with the Department of State, we are planning for winning teams to travel to a major international conference on sustainable development to be held in Rio de Janeiro, Brazil, in 2012. Interactions with scientists from around the world will have a lasting impression on these students whose paths may lead toward global science and technology.

We are solely funded through philanthropic grants and individual and corporate entities. Our biggest challenge is funding the program so we can scale it to reach mass numbers of students and expand the services and programs associated with the context. The Spirit of Innovation Awards program is the only incentivized learning program to combine STEM with innovation and entrepreneurship.

Mr. Chairman, distinguished Members, I believe we must all accept the challenge to embrace and propel our students to tomorrow's innovation generation. While our education system may be broken, our students are not. When given the opportunities, their talents shine. They are amazing, they are innovative and they are brilliant. Our students will be the next Steve Jobs, Bill Gates, Mark Zuckerberg, Larry Page and Sergey Brin. This is how we engage America in STEM education and this is how we build the innovative workforce for the future. We need to leave a better coun-

try for our children but we also need to leave better children for our country.

Thank you for your kind attention and I will be delighted to answer your questions.

[The prepared statement of Mrs. Conrad follows:]

PREPARED STATEMENT OF MRS. NANCY CONRAD, CHAIRMAN AND FOUNDER OF THE CONRAD FOUNDATION

1. Please describe in detail the STEM competition(s) your organization leads, including its history, development, participation, parent/teacher involvement, costs associated with the competition and with participation in the competition, and success rates/stories.

Built on the Legacy of A Pioneer

The Conrad Foundation and its programs are based on the rich legacy of the late Apollo 12 Astronaut and entrepreneur, Charles “Pete” Conrad. The Foundation was created by Pete’s wife, Nancy Conrad, a teacher, education activist and Chairman of the Foundation.

Pete was expelled from a prestigious school in the 11th grade, at which time he couldn’t read and he couldn’t spell. In those days, educators didn’t always recognize dyslexia. His mother took him to a small school where the headmaster saw something special in this young man and took him under his wing. Pete went on to earn a scholarship to Princeton where he became an aeronautical engineer.

He was a test pilot when President Kennedy put out the call for this country to go to the Moon. Pete was accepted to enter NASA’s manned spaceflight program where he flew four missions including Gemini V, Gemini XI, Apollo 12 and Skylab. He was the third man to walk on the Moon and was awarded a Congressional Space Medal of Honor for his rescue of Skylab. Toward the end of his life, Pete was working on the commercialization of spaceflight.

He was pioneer of the past and at the leading edge of the vision of the future. Pete got his moon shot because an educator took him under his wing. Our program is designed to help teachers to take students under their wing, provide mentorship and give students their “Moon Shot.”

Why Our Contest Works

The Conrad Foundation’s Spirit of Innovation Awards (SOIA) presents high school student participants with a very broad challenge: create an innovative product that can be used to address a real-world problem with a real-world solution which can ultimately be viable in the commercial marketplace.

The competition is free of charge to students in the United States and is also open at no cost to international students. These students are given a blank slate within several major categories that can include clean energy, aerospace exploration, and health and nutrition. But they’re not just asked to complete a science project: they are required to conduct research to determine their creation’s potential market impact and develop a full business plan.

Utilizing a network of world-renowned scientists, engineers, academics, and business leaders, the Conrad Foundation connects the student teams with mentors to assist in making their ideas a reality.

A panel of experts selects the top entries to attend the annual Innovation Summit, hosted at NASA–Ames Research Center, where students present their technologies. There, program participants also have the opportunity to interact in a peer to peer environment, with a slate of guests who have been among the foremost science, business and academic leaders in the world.

Each year several student teams are also chosen to go into the “Portal,” where the Conrad Foundation helps students acquire the patents and funding needed to bring their creations to the open market.

Products of Our Success

Over the course of the past four years of our program engaged more than 1,000 students from a broad socioeconomic demographic nationwide.

Our student teams received technology patents and recognition from government regulatory agencies and the President. They are featured in national and international media including BBC, Fox News, CNN, Elle Girl, MTV Geek, and Popular Science.

Our students are also sought after to serve as speakers at national and international industry and academic conferences such as the International Space Devel-

opment Conference, AIAA conferences and TEDxSF. There are former student projects now archived in the John F. Kennedy Presidential Library.

A few examples of our exemplary students' achievements include:

Daniel and Isaac, high school students from Katy, Texas, have two patents on off-shore geothermal energy generation system that captures energy using deep sea hydrothermal vents as a heat source. It would use a modular power network to transfer the energy to shore. They been interviewed by the BBC, featured in Popular Science Magazine and archived into the Kennedy Presidential Library.

Mikayla and Shannon, high school students from Michigan, created a nutrition bar that meets NASA's exacting standards for nutrition and stability in micro-gravity situations. They have been interviewed by Elle Magazine, MTV, CNN, and Fox, and have been honored at the White House. Recently their product was flown aboard NASA's shuttle mission STS-134.

Building on Strong Metrics

To ensure we are meeting our mission of improving the delivery of STEM education to students and providing quality mentorship opportunities, we survey teachers and students at the completion of the SoIA. Developed by a former student competitor and a NASA education specialist, the surveys are used to assess the success and value of the program as a tool for project-based learning in STEM education. Across the board, both students and teachers agree that the format provided by the Conrad Foundation enhances and improves student interest in STEM education and STEM career opportunities.

- 2. Elaborate on the public/private partnerships and initiatives that make the competition a reality, the role of each partner, why an entity chooses to be a partner, and how the partnership is successfully inspiring a future STEM workforce.**

Partners Help Students Achieve Their "Moon Shot"

Because our Foundation is built on the legacy of Pete Conrad, the third man to walk on the Moon, our business model for our program is based upon America's original plan to achieve the "Moon Shot". To reach the moon, the U.S. went incrementally, through a rich collaboration of academia, government and industry.

The Foundation mirrors that philosophy by partnering with the best academic, industry and corporate organizations in North America. All our partners recognize the value of investing in STEM education and preparing and nurturing the future workforce of our country.

The Conrad Foundation established three categories with corresponding criteria to define new and current partnerships:

Corporate Partners: We select Corporate Partners for each category that align with our mission and are respected leaders in the category field. This year, these sponsors include Lockheed Martin, PepsiCo and Kraft Foods.

Challenge Partners: Each year we have one official Challenge Partner for each category to provide expert mentors, judges for submissions and post-competition opportunities for students such as speaking at national conferences, internships and career opportunities. Current partners include American Institute of Aeronautics and Astronautics, American Society for Nutrition and the William James Foundation.

Program Supporters: These are organizations or programs that support the Foundation and SoIA year after year. We thank them for promoting our program through their networks and being a great resource for the completion. We put them on our website and invite them to the Innovation Summit. Our primary Program Supporters include NASA, National Institute of Health, Sigma Xi, museums and science centers, Popular Science Magazine and Space Ref.

This year, in partnership with the Department of State, we are planning for winning teams to travel to a major international conference on sustainable development to be held in Rio de Janeiro, Brazil, in 2012. Interactions with scientists from around the world will have a lasting impression on the students, whose paths may be toward global science and technology.

- 3. Expand on the current success of the program/initiative and its contribution to inspire and affect the workforce of tomorrow? What are the biggest challenges and barriers that you face?**

Nurturing Tomorrow's Workforce Today

The Spirit of Innovation Awards program reaches all socio-economic levels and ranges from students from the Navajo Nation to Thomas Jefferson High School for Science and Technology, the number one rated school in the country. Our program attracts high school aged students from coast to coast. Roughly one-third of our students are young women, one-third are underserved and one-third are students who enter many competitions.

The Spirit of Innovation Awards is the only competition for teams of high school students combining STEM, innovation, entrepreneurship and education to solve real world challenges. Further, it is one of the only programs that actively collaborates with other STEM organizations. This competition is an open platform, free and available to all socioeconomic levels nationwide.

Our students learn design thinking skills and the system of incremental development from idea to design to reality. This competition isn't about proving how many STEM facts students know. It is about taking everything they know, learning more, and working as a team with their fellow students, teachers and mentors to create something commercially viable with large-scale social impact. While we help these students understand the importance of what they are learning, they also have the opportunity to innovate and gain recognition at a very early age for their product designs.

As a result of our program, several of our students received patents and media recognition, interacted with government, industry and academic leaders, and gained the opportunity to commercialize their product ideas. We are not only hosting a program, we are driving a movement. We are giving teachers an exciting and dynamic way to teach STEM, and we are growing the young innovators who will sustain our knowledge-based economy.

Addressing Our Challenges

One of the largest hurdles to overcome was developing a way to scale the program in such a way that we can reach a greater number of participants. In order to increase the depth of participation, we identified two simple ways to create a significant amount of improvement in the contest.

- Improve the way we process team applications, which we've accomplished through the implementation of an online judging platform that will be used by our Challenge Partner judges.
- Streamline the application process into a three phase approach which makes the initial ask of the student teams simpler and the overall process easier for the coaches to manage.

However, because we are solely funded through government and philanthropic grants, and individual and corporate donations, our biggest challenge is funding the program so we can scale it to reach mass numbers of students and expand the services and programs associated with the contest.

4. Please describe the effects your competition has on the students who participate and elaborate on any other STEM education-focused activities your organization spearheads.

We have a vision for the 21st century learning environment of student-centered, immersive learning, fueled by collaboration with teachers and public/private organizations. When we set the goal of creating a nation populated with creative student innovators, we knew the end result would be building a future rich in economic diversity, complete with a well prepared workforce and visionary future leaders.

As a result of our program, several of our students have received patents and media recognition, interacted with government, industry and academic leaders, and gained the opportunity to commercialize their product ideas. In addition, we introduce students to new and possibly unconsidered career paths in the STEM industries by giving them unequalled access to mentors and experts in a broad array of specializations. These mentors and partners are guides to college course recommendations, internships and job shadowing opportunities.

We continue to engage our student alumni by encouraging them to serve as mentors and provide peer feedback to current-year teams. These alumni will also help us recruit new competitors in an effort to help grow and expand the contest.

The Conrad Foundation is a firm believer in continuous evaluation to ensure we are meeting the needs of our nation and providing the best quality support to the field of education. While SoIA is our flagship program, as we grow as an organization, we intend to develop additional programs to help support the mission of promoting the value of STEM education nationwide.

5. How can we as a nation spark a greater student interest in math and science education?

The aim of our competition is to ignite America's interest and passion for STEM education. We do this by building relationships in an engaged learning community of students, teachers, mentors, advocates, industry, academia, venture capitalists, government who are excited about the purpose of STEM education.

By committing to this course of action we help students understand that what they are learning has relevance, which has been proven to be a critical element in student engagement of education programs. By expecting students, teachers and mentors to embrace a rigorous program that blends STEM, innovation and entrepreneurship, we are growing the young innovators who will sustain our knowledge-based economy.

Chairman HALL. We thank you.

I do now recognize Mr. Gallagher for five minutes.

STATEMENT OF MR. MICHAEL GALLAGHER, PRESIDENT AND CEO OF ENTERTAINMENT SOFTWARE ASSOCIATION

Mr. GALLAGHER. Chairman Hall, Ranking Member Johnson, distinguished Members of the Committee, I am grateful for the opportunity to testify at this hearing this morning. My name is Michael Gallagher and I am the President and CEO of the Entertainment Software Association, the trade association that represents the industry that creates video games on virtually every device that has a screen and a battery including video game consoles, personal computers, handheld devices like cell phones, and over the Internet.

We at ESA, the staff and the members, are very appreciative of the continued focus of this Committee on the limitless value of technology and education and the importance that that focus has to the American workforce in the years ahead as well as today, and we are grateful to be part of this conversation.

Webster's Dictionary defines to invent is "to produce for the first time through the use of the imagination or of ingenious thinking and experiment." Inventions are the bedrock of the United States economy since it was born. If you look at our history in addition to the current technologies that Mrs. Conrad highlighted but going back to the light bulb, planes, trains and automobiles, the cell phone, telephones in general, computer and the Internet, each of these breakthroughs, each of these breakthroughs, each of these inventions created and spawned scores of millions of jobs for generations of Americans. What they all share in common are root elements in STEM and in STEM education. It is of vital economic interest for our country that we continue to be as dynamic and world-leading as possible in the area of educating our youth in STEM.

Yet today there is a yawning gap between our needs as a society and as a country and what we are producing in the classroom, and that gap is recognized in bicameral, bipartisan, State and Federal arenas. Business and the public sector all agree that we are in a mode where we must enhance our productivity in the classroom for the benefit of our current and our future economic aspirations.

The video game industry is living in this challenge. Today, we are a \$25 billion domestic industry. We have grown 120 percent over the last five years and the jobs that are created are across the country in 30 different states where we have sites and enormous productivity coming from jobs in our industry. These jobs are fundamentally dependent on physics, math, computer science and the

core STEM curricula that this hearing is focused upon. However, beyond our industry, we also have the need of broader corporate America looking at trying to innovate and invent in today's economy, and in a study that was concluded a year ago, over 100 of the Fortune 500 companies indicated that they would be using video game technology to enhance the efficiency and effectiveness of their workforce, and these are companies like Bank of America, IBM, Canon, American Express and others who are seeing the value of the technology that is inherent in what we do.

Looking beyond, however, just the corporate opportunity, ESA was approached by the Joan Ganz Cooney Center, otherwise known as Sesame Street, about three years ago and was challenged to do more in the area of education because they as educators understood the connection between our industry and youth, and many studies show—Pew has a study that shows not surprisingly that 97 percent of boys play video games but 94 percent of girls do as well, and so we have a medium that is creative, that is dynamic, that is captivating to the youth of our country. We should be capturing that energy. So in partnership with Microsoft, PlayStation, Electronic Arts within our industry as well as the Joan Ganz Cooney Center, the MacArthur Foundation, E-Line Ventures and AMD, we launched two different competitions focused on capturing that interest of youth and putting it into the classroom in a practical, exciting way for education purposes.

I look forward in the question-and-answer session to detailing the specifics of those competitions and their success, but this last March, we awarded—one of the national challenges awarded its prizes for the first round in the first year of competition, there were over 500 entrants in the competition and we brought a short video for the Committee today to give you a flavor of what is happening in the classroom with the ideas that come from our industry, and if we could roll the clip. I thank you for the opportunity to be here today.

[Video playback.]

[The prepared statement of Mr. Gallagher follows:]

PREPARED STATEMENT OF MR. MICHAEL D. GALLAGHER, PRESIDENT AND CEO OF
ENTERTAINMENT SOFTWARE ASSOCIATION

Introduction

Chairman Hall, Ranking Member Johnson, and distinguished Members of the Committee, I am grateful for the opportunity to testify at this hearing. My name is Michael D. Gallagher, and I am the President and CEO of the Entertainment Software Association (ESA). ESA is the U.S. trade association in service to companies that publish computer and video games for video game consoles, personal computers, the Internet, and mobile phones. The members and staff at ESA appreciate your continued focus on the limitless value of technology in education, and its importance to the American workforce, both today and in the future, and we are grateful to be part of this conversation.

If this country is to thrive in the coming years of the 21st Century and beyond, our nation's children must regain their position as elite students of science, technology, engineering, and math. Those four subjects, known collectively as STEM, are the key to unlocking a future of American prosperity.

Over the past several years, ESA and the video game industry have undertaken several initiatives in an attempt to play a catalytic positive role in engaging children in core STEM subjects. These initiatives, designed to tap into our industry's culture of innovation and children's enthusiasm toward video games, involve wide-ranging public-private partnerships. The initiatives that ESA and its partners have undertaken will hopefully be impactful on a larger scale in terms of engaging American

schoolchildren on STEM. While these initiatives are in their infancy and their effect cannot yet be fully measured, three things can be sure about the initiatives: first, research from organizations like the Federation of American Scientists, National Science Foundation and the Joan Ganz Cooney Center at Sesame Workshop have highlighted the enormous potential of computer and video games to foster highly engaged, effective learning and motivation for STEM; second the use of games and game-making for education is being greeted by children with tremendous enthusiasm as you will see in the video footage that will be part my testimony and third, all of the ESA STEM video game partnerships have collectively cost the American taxpayers a total of zero dollars.

The various roles of ESA and the entertainment software industry in these initiatives—either as a convener, a financial supporter, or a project manager—are roles that we are honored to play. As the House Committee on Science, Space, and Technology is demonstrating by virtue of this hearing, government at all levels can enlist the further support of private sector experts and examples to improve America's educational performance by drawing attention to initiatives like these.

STEM as the Foundation of the Entertainment Software Industry

The video game industry has a keen understanding of the importance of STEM. We are an innovative and dynamic \$25 billion industry that is based almost entirely on STEM.

This is a rapidly expanding nationwide industry that grew 120% over the past five years and employs over 120,000 Americans, including engineers, animators, graphic designers, musicians, and writers, who earn an average salary of \$90,000. These high tech, high-paying video game jobs are at the forefront of 21st Century, creative “next” economy, and are a real-world manifestation of the importance of quality STEM and arts education programs.

While the Entertainment Software Association represents video game publishers with worldwide large scale presence, it also includes smaller, American video game companies like 38 Studios of Providence, Rhode Island and Her Interactive in Bellevue, Washington. Many companies in our industry started as the idea of a single entrepreneur, then grew into small businesses before blossoming into successful enterprises. One such company, Epic Games, headquartered in Cary, NC, has grown from humble roots into a multinational entity with its own video game engine technology that is used throughout the industry.

American colleges and universities are swiftly realizing that our industry is where the jobs are. Currently, 343 U.S. trade schools, colleges and universities offer courses in video game design and development, including 43 university graduate programs. Mister Chairman and Madam Ranking Member, Texas alone is home to 24 such programs, including prominent programs at your alma maters, Southern Methodist University. Speaking of the Lone Star State, Texas is quickly becoming a major center for high-paying, high-tech video game industry jobs. Thanks to a competitive state tax incentive and the leadership of Governor Perry, Texas recently leapfrogged Washington to become the number two state in the country for video game jobs, adding 1,700 positions in a fourteen month period alone (from April 2009 to August 2010).

Though our industry is strongly represented in places like Austin, Silicon Valley, Seattle, and Los Angeles, we are a nationwide industry with employees in more than 30 states. As the explosion of casual games and online app sales has shown, no single geographic area has a monopoly on creativity; anyone with an idea, a broadband connection, and programming skills can bring the world the next Angry Birds. But again, none of these economic growth opportunities are possible without a solid and broadly-based STEM foundation.

Presidential Acknowledgement of the Importance of STEM

In order for Americans to access such high-tech, high paying careers, they need the proper skill sets for these opportunities. The fundamental necessity of STEM education has not gone unnoticed by the White House's two most recent occupants.

In 2007, President George W. Bush noted that “(w)e want to make sure we strengthen math and science, because we can't be a competitive nation without more scientists and more mathematicians. Because in order for us to make sure the best jobs are in America requires us having mathematicians and scientists and engineers and physicists.”

Similarly, in September of last year, President Obama announced his initiative aimed at stimulating the private sector's recruitment of 10,000 STEM teachers over the next two years, when he stated that “(s)trengthening STEM education is vital to preparing our students to compete in the 21st century economy and we need to recruit and train math and science teachers to support our nation's students.”

This past April, President Obama spoke again about STEM's importance at Facebook's Palo Alto headquarters, emphasizing that STEM education—especially to girls and minority students—is one of the most important investments the U.S. can make if it hopes to produce college and career-ready students.

The Educational Power of Video Games

Although there is general agreement that STEM education is a key to rekindling America's global economic competitiveness, we nevertheless face a critical STEM skills shortage. The current unemployment crisis is not simply a jobs problem, it is a skills problem, and it is our nation's challenge to train people to qualify for the high-skilled positions necessary to compete and thrive in the global economy. According to the Bureau of Labor Statistics, the August 2011 unemployment rate for those with bachelor's degrees or higher was 4.3%. For those that were just high school graduates, it was 9.6%. To give one example in our industry, Microsoft recently reported that it has 4,551 unfilled job openings, more than half of which are for computer science positions.

The United States must educate and develop its own supply of talent for the 21st century ideas-based economy, and STEM is essential to filling the workforce of the future. However, education experts tell us that children increasingly lose interest in core STEM subjects because students do not find these subjects engaging, and they don't see the relevance of STEM to their lives.

Since video games enjoy such high nationwide levels of adoption and enjoyment, they can be important educational tools to help bridge the current STEM gap. They are ubiquitous in children's lives—46 million children between 5 and 17 years old are currently gamers, according to The NPD Group. As the Pew Trust and MacArthur Foundation recently found, "(f)ully 97% of teens ages 12–17 play computer, web, portable, or console games." http://www.macfound.org/atf/cf/%7BB0386CE3-8B29-4162-8098-E466FB856794%7D/PEW_DML_REPORT_080916.PDF

Researchers and educators are increasingly arriving at the conclusion that computer and video games are one of the most effective ways to reach America's children. "Digital technologies are helping us to re-imagine learning," stated Connie Yowell, MacArthur's Director of Education. "In the digital age, the learning environment is turned on its head—it's no longer just the dynamic of the student, the teacher and the curriculum. Today, kids learn and interact with others—even from around the world—every time they go online, or play a video game, or engage through a social networking site." http://www.macfound.org/site/c.lkLXJ8MQKrH/b.6035061/k.43F1/Digital_Media_Learning_Competition.htm. MacArthur is currently funding a \$50 million, five year digital media and learning initiative.

They help address many of the challenges confronting our current education system—a lack of student engagement, for example. Educators want to take advantage of the enthusiasm of our children for gaming and many are using our technology as teaching devices. New programs that incorporate video games into traditional education engage students of all demographic groups and academic inclinations.

This approach makes intuitive sense: our economy is increasingly digital, and our education system should map to it. Video games promote the skills needed to effectively operate in a global economy—complex systems thinking, critical analysis, strategic planning, creativity, and collaboration. The workplaces of today are radically different from those of the 1950s; however, our classrooms are largely the same.

The key question is how to tap into the natural passion of youth for playing and making video games, and connect this passion to building a motivation for STEM and other core curriculum subjects and developing critical 21st century skills and job pathways. There is enormous power and potential in the medium. To fully realize this potential, we will need innovative public private partnerships, and I applaud the leadership of this Committee in this regard.

There is great opportunity for highly engaged STEM learning not only in having students play well design game, but also in having them make them. As Alan Gershenfeld, founder of E-Line Media (one of ESA's STEM Challenge partners), points out, "(d)esigning a digital game requires one to think analytically and holistically about games as systems, to experiment and test out theories, to solve problems, to think critically, and to effectively create and collaborate with peers and mentors. These are all skills that will be needed in a twenty-first century where virtually every job will involve navigating a complex, ever-changing, digitally networked global landscape and where many of the future jobs have yet to be invented. Designing and developing video games is certainly a very complex process—and yet many kids can't wait to jump in and start."

There is an aspirational aspect to this discussion that must be considered, one that taps into the notion of which careers children aspire to undertake when they

reach adulthood. If children see video game design as a ?cool? and viable career path, and STEM as the foundation of that path, then these subjects will become more compelling and relevant to them. The space program (and children’s fascination with astronauts) spawned two generations of aerospace engineers. We believe that video games can provide a similar role as a catalyst for future generations of members of the high-tech sector; a sector that represents a critical component of this country’s path to economic growth.

In June 2009, the Joan Ganz Cooney Center at Sesame Workshop released a report, supported by the Robert Wood Johnson Foundation, titled *Game Changer: Investing in Digital Play to Advance Children’s Learning and Health* which concluded that computer and video games provide “an important, untapped opportunity” to support learning, particularly when children and adults play together. That same year, the Center launched its Innovation in Children’s Digital Media prize program, providing incentives for university media labs as well as the entertainment software industry to develop research-based games that promote learning through digital media.

Games also use new technologies to incorporate principles crucial to human cognitive learning. University of Arizona education professor Dr. James Paul Gee recently concluded that video games intertwine instruction and demonstration, a more effective learning technique. In his book, *What Video Games Have to Teach Us About Learning and Literacy*, Gee points out that video games, unlike the U.S. Education system, are designed to effectively engage youth because video games are interactive, customized, and “pleasantly frustrating.” <http://newlearningonline.com/new-learning/chapter-9-learning-communities-at-work/james-gee-on-video-games-and-learning/> Therefore, video games are great assessment tools in learning; you don’t advance or “level up” if you haven’t internalized the appropriate knowledge. Moreover, students who design video games around core academic subjects like STEM, by becoming not just consumers but producers of educationally beneficial content, are more interested in pursuing careers in these fields, as LiveScience reported in its recent article “Video Game Design Program Boosts Interest in Science Careers.” <http://www.livescience.com/10197-video-game-design-program-boosts-interest-science-careers.html>

The Information Technology & Innovation Foundation highlighted the educational benefits of game play in a 2010 report on the need to transform education in STEM subjects as a way of refueling the U.S. innovation economy. The report stated that “videogames are well structured to be learning experiences,” because they provide players with significant feedback, feature embedded rewards systems, instant assessment, engage a variety of senses, allow a user to determine the pace of play, and encourage collaborative learning in instances of multi-user play.

Real World Examples

A recent example of an innovative approach to utilize video games in a learning environment, is the iCivics initiative, in which former Supreme Court Justice Sandra Day O’Connor collaborated with Georgetown University Law School and Arizona State University to develop an online, game-based learning platform to teach students about civics. First launched in 2009, iCivics now features five games about constitutional law and the branches of U.S. government, each of which also comes with suggested lesson plans that are tailored to meet state-specific learning standards. In 2011, the ESA Foundation awarded a grant to iCivics to develop its newest offering, an international relations focused, multiplayer game available on the iCivics website and Facebook.

An example of putting these beliefs into practice is Quest to Learn, a New York City public school grounded in principles of game design, the first of its kind. Chicago Quest, following the Quest to Learn model, just opened for the current school year. http://articles.chicagotribune.com/2011-03-29/news/ct-met-video-game-school-0330-20110329_1_video-game-elizabeth-purvis-charters Quest to Learn is the first public school in the nation based on the principles of game design. <http://www.360kid.com/blog/2010/01/salen-interview/> As the New York Times recently described the philosophy of Quest to Learn and Katie Salen, its founder, “building a game—even the kind of simple game a sixth grader might build—is equivalent to building a mini-world, a dynamic system governed by a set of rules, complete with challenges, obstacles and goals. At its best, game design can be an interdisciplinary exercise involving math, writing, art, computer programming, deductive reasoning and critical thinking skills.” <http://www.nytimes.com/2010/09/19/magazine/19video-t.html?pagewanted=1>

As the generation that grew up with video games enters and assumes leadership positions in the work place, computer and video games are being increasingly used to conduct business. A growing number of major companies, from automobile manu-

facturers to beverage producers, employ video games to find and train employees and increase sales among their younger tech savvy customers. With the video game industry booming and its products gaining broader acceptance, the use of games in the work place is certain to expand in the years ahead. By the end of 2012, between 100 and 135 of global Fortune 500 companies will have adopted gaming for learning purposes, according to The Apply Group. One entertainment software company, Games2Train, has developed employee training games for American Express, Bank of America, IBM, JP Morgan Chase, Nokia and Pfizer. In addition, Canon uses a video game in which repairmen must drag and drop parts into the right spot on a copier to train technicians. IBM has also produced *Innov8*, a free, interactive game that teaches graduate students business and technology skills.

ESA STEM Initiatives

In collaboration with our partners the MacArthur Foundation, the Joan Ganz Cooney Center at Sesame Workshop, E-Line Ventures, AMD, and our ESA member company partners—Sony Computer Entertainment, Electronic Arts (EA), and Microsoft—ESA helped launch two STEM video game design challenges.

In 2010, ESA launched its first STEM competition, *Game Changer*, with MacArthur, Sony PlayStation, and Electronic Arts. ESA's effort is a component of MacArthur Foundation's \$2 million annual Digital Media and Learning Competition, which "advances the most innovative approaches to learning through games, social networks and mobile devices." This competition challenged developers to create STEM-related learning content for two existing video game titles that were popular with children—Sony's PlayStation's *LittleBigPlanet* and EA's *Spore*.

The second STEM competition, the *National STEM Game Challenge*, was undertaken with founding partners Joan Ganz Cooney Center at Sesame Workshop, E-Line Media, the AMD Foundation, and Microsoft, along with outreach partners including the American Library Association, Boys & Girls Clubs of America, The International Game Developers Association, the American Association of School Librarians, and BrainPOP. The Challenge was launched in September 2010 by President Obama as part of the national "Educate to Innovate" campaign.

The President noted that "(o)ur success as a nation depends on strengthening America's role as the world's engine of discovery and innovation." The President added, "I applaud partners in the National STEM Video Game Challenge for lending their resources, expertise, and their enthusiasm to the task of strengthening America's leadership in the 21st century by improving education in science, technology, engineering and math."

The Challenge encourages the design of new video games that engage America's youth in STEM-related learning by targeting the participation of developers across three demographics: middle school youth, college game developers, and professional game designers. Last year, the youth segment of the contest attracted over 500 submissions from children all over the country, the winners of which are featured in the video shown during my live testimony. The second year of the Challenge will launch this Friday, September 16th as part of the Department of Education's Digital Promises initiative, which showcases the positive role that the federal government can play, at no cost to taxpayers, of incentivizing public-private partnerships to develop innovative approaches to vexing policy issues.

Each year during the video game industry's preeminent global computer and video game trade show—the E3 Expo—ESA organizes the annual Games and Learning Summit to promote a dialogue among industry leaders, educators, policy makers, and others on the growing role of video games in education, health, and economic development. This year's summit featured over 60 experts and spawned several public-private partnerships that, while currently in their nascent state, will hopefully prove to be as successful as the *Game Changer and STEM Video Game Challenge*.

Earlier this year, ESA funded and organized *The Atlantic's* "Technologies in Education Forum." The forum focused on "the new policies, technologies, and tools available to those working on the front lines to bolster American student learning and achievement, especially in the critically important STEM curricula." The audience of stakeholders learned what public policies are necessary to bring new technologies into classrooms, how educational video games are changing the way students learn, and how new technologies can be used to improve vital intellectual skills and prepare the near future American workforce to compete in an increasingly advanced global economy. The forum featured keynote speakers from Congress and the Administration and three panels covering the future of technology in education, the path to a new curriculum, and the long term benefits of increasing the role of technology in workforce development. The panelists included experts from the Federation of American Scientists, DARPA, the National Math and Science Initiative, among others.

Another notable example in the public-private partnership STEM realm, while not an ESA initiative, is the *Girlstart* program in Texas, which stems from the work of ESA STEM partner AMD, as well as Dell (in collaboration with the Texas Alliance for Minorities in Engineering and the Boys and Girls Clubs of America). The *Girlstart* initiative seeks to empower girls in science, technology, math and engineering by establishing after-school programs, camps and workshops where participants can hone skills used to create computer and video games and explore their interests in these and other STEM-related professions.

ESA Foundation's STEM-related Grants

The ESA Foundation (ESAF) is dedicated to supporting positive programs and opportunities that improve the lives of America's youth, and has raised over \$11 million for a wide variety of worthy causes. The Foundation awarded a range of grants that further STEM education and exploration through video game technology. An ESAF grant in 2011 to Case Western Reserve University supported the Great Lakes Game Project Challenge through a partnership between Electrical Engineering and Computer Science Department and the Great Lakes Energy Institute at Case. Students will compete to create a video game focused on wind energy and sustainable energy generation.

The 2011 ESAF grant to a group called Edheads will fund the development of an online interactive engineering design experience centering on nanoparticles. Edheads will work with the Ohio State University Nanoscience and Engineering Center to create a video game that will blend engineering, human health and medicine, and critical thinking skills to appeal to girls ages 15–18 who are considering medical careers.

Several years ago, ESAF made a three-year commitment to the Federation of American Scientists (FAS) to support additional teacher training, improve game support materials, increase outreach activities and widen distribution and evaluation. FAS created *Immune Attack*, an educational video game that introduces basic concepts of human immunology to middle school, high school and entry-level college students. Designed as a supplemental learning tool, *Immune Attack* aims to familiarize students with molecular biology and cell biology concepts as they pertain to the battle between white blood cells and infectious agents. ESAF first supported distribution and development of materials as well as teacher trainings for the game in 2007.

ESAF awarded a grant to the World Wide Workshop Foundation in 2011 to expand the integration of the *Globaloria Platform* in low-income rural counties in West Virginia. *Globaloria* is an online social learning network for designing and constructing web-games, which includes programmable wikis and blogs, game programming tutorials, content resources and a self-paced curriculum. *Globaloria* "seeks to transform education by merging technical and computational skills into a rigorous academic curriculum." <http://www.worldwideworkshop.org/programs/globaloria/globaloria-in-wv>

ESAF looks forward to announcing new grant winners for similar projects in the next month.

Conclusion

STEM education is critically important to our economic success as a nation. To better engage youth in learning opportunities around STEM skills and processes, we must reach children on their own turf. The entertainment software industry is playing a critical role in helping to address America's STEM skills crisis by leveraging the creativity of our industry to showcase the benefits of STEM education. Video games offer a unique way to captivate the imagination of students with STEM by tying these subjects to familiar activities which they enjoy. Video games provide a powerful environment for STEM learning by letting players interact with and even design a story, rather than passively consume it. In other words, America needs to build a future workforce of not just consumers, but creators.

As I noted above, visionary educators are increasingly recognizing the positive impact of entertainment software and utilizing games as a teaching device in a growing number of classrooms, especially in the area of STEM. In doing so, they are embracing the cultural and technological shifts of the 21st century and expanding the use of a favorite leisure activity, computer and video games, into a critical and still-emerging educational resource.

As Michael Levine of the Joan Ganz Cooney Center at Sesame Workshop recently noted, "(t)he transition to a technology-rich education system that maps to the modern knowledge-based economy is happening. There is no putting the digital genie back into a bottle. It's our job—from game developers to the White House—to harness the creative power and potential of gaming to help schools engage and excite

a new generation of technologically-savvy learners.” We at ESA and in the entertainment software industry are honored to play a role in catalyzing this transition.

Chairman HALL. I now thank all of you for your testimony, and remind Members of the Committee that we are still limited to five minutes on our questions, and I will yield myself five minutes to start with.

I just—I want to start out by saying how amazed I am, Mr. Norman, at the progress you have made from the day you broke ground out there and how amazed I was when I just accidentally stopped by to visit you and to meet you there and to get to walk through your place to see youngsters at tables and the success just obvious and you trying to buy all the property around you to where you could expand.

I thought back to Eric Johnson, who was a great man that bought Texas Instruments, and you know, I was talking to him one time and he said he bought Texas Instruments on December the 6th, 1941. On December 7, 1941, he was driving out to see what he had bought, and I said as the matter of an engineer, you are great, but as a matter of timing, you are super because December 7, 1941, is a date that lives in infamy that started World War II and TI just went straight up like your company has done.

I had the privilege of witnessing the VEX Robotics world championship earlier this year, and we walked through and got to meet with a lot of those youngsters. Talking to these brilliant and engaging young people and watching their enthusiasm as they competed and talked to us, both of us, about their robots and that was really inspiring to me, and if I recall correctly, there is no prize, no monetary or otherwise prize for the winners of the VEX Robotics world championship other than the thrill of victory, and those that lost seemed to be just as thrilled to have participated and the one thing they were really moved in on was next year. They were getting ready for the next one.

What is providing the motivation for these kids to compete year after year? What do you find?

Mr. NORMAN. Well, I think the main thing that is driving it, I mean, obviously it is kind of like the Flintstones vitamins: it is fun but they don't really know it is good for them. And once you start getting them involved, I had a case with my own son, he didn't know what I did until he started seeing the robotics and the programs and stuff we did around that program. So some of these parents that are engineers have for the first time taught their kids what they have done and what they do for a living and they see us as professionals in the workforce creating these things, and especially for our toy division for the high school students working for us and the college interns to see something they worked on all of a sudden appear in the real world is pretty amazing. So that robotics competition does that same thing with all those corporate sponsors that are involved. They get kind of a peek into what that company does and what it would be like to work in that kind of environment with science and technology as their background.

Chairman HALL. VEX Robotics world championships is an international event. Share a little more with us, if you will, about how these teams and alliances from different parts of the world work together in the competition and how this provides and enhances

very valuable communication and cooperation skills among the contestants.

Mr. NORMAN. One of the aspects of the competition is basically putting—forcing two teams to work together as an alliance against another two teams, and it changes each match so you are not sure who you are competing with the next time. So it forces kind of that be nice and don't do anything you shouldn't, and it kind of teaches them that professional respect you should have as you work in the real environment. So once again, it is life lessons as well as science and technology.

Chairman HALL. I will send my grandchildren over there for you to talk to.

What makes VEX Robotics different from other programs that are available today and what does it take to accelerate growth and reach more students with this program and what barriers do you face in achieving accelerated growth?

Mr. NORMAN. Well—

Chairman HALL. What holds you back? What are you concerned with?

Mr. NORMAN. Well, we have been involved, like I said, for 20 years, and I have been involved in a lot of the programs out there and a lot of them are extremely good at what they do. What kind of differentiates VEX is we started and dissected everything as engineers do. We started with the platform, made sure we had the most high-tech platform we have and also make it scalable so it is cost-effective. We looked at the program and how important the program was in mentorship from these other companies, and the partners that we went—you saw some of the 501(c)(3)'s we are involved with and getting those partners there. Then comes the daytime curriculum. You need to be in the daytime as well as extra-curricular, and we actually accomplished both of those through our program, and really our growth has been all grassroots, finding these companies to spend money instead of recruiting people to put their name out there in front of these students and help their environment. And then, you know, obviously any money we would get would help accelerate that path but right now we are doing an extremely good job doing it the grassroots way.

Chairman HALL. I have about nine seconds left. Mrs. Conrad and Mr. Gallagher, I'd want to ask you, what do you find to be the most rewarding and aspiring aspects of the work you are doing, but I may get a chance to do that later. If I don't, I am going to ask unanimous consent to write letters to you and ask you to answer these questions.

At this time I recognize Mrs. Johnson, the Ranking Member of this Committee, a very good friend of mine and a neighbor of mine in Texas. I recognize you for five minutes, Mrs. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Hall.

I am very impressed with the witnesses today and I am delighted that you have taken time to come.

I have been working with some nonprofit groups that are attempting to improve and be a part of volunteers in STEM programs around the country—two hundred and some chapters—and one of the things that we have encountered is a lack of evaluation tools. So what I would like to do is ask you to share some of the tools

you use to evaluate your program and its effectiveness with students and then allow me to copy from you. So would you start, Mr. Norman?

Mr. NORMAN. Sure. Well, I mean, obviously there is the normal studies. We just recently did a study through Georgia Tech to kind of put quantitative numbers on what is happening, but for us, it is really easy to see what we saw even in our local high school is all of these students that started not only started heading towards that science and technology role but they also became the leaders in most of the organizations within the school, anything from a social thing to a chess club to a math club, and it really gave them that rise to be a leader as well.

So that is one way, and also once again, they come back in jobs. We see a lot of them come back as co-ops, and we literally build our entire workforce from the robotics community. That is how we have done it. We have eight team leaders from around the country that are leaders in our company now.

Mrs. CONRAD. We have done something quite unique, I think. One of the systems by which we measure what we do—am I on? Now I am on. Thank you. I need adult supervision all the time.

Chairman HALL. That is what is good about having an engineer.

Mrs. CONRAD. We need an engineer. Is there an engineer?

So we have a system that measures what we do. We work with a former NASA educator to help us with that. But in addition, we have a system that was designed by a student that measures the student's response to the work that we are doing. The student actually entered the ISEF, the Intel competition with this matrix and used us as a guinea pig, and it was just such a fantastic system to measure a student's input into the program so we have now adopted his tool as part of our measuring system, and I think if you are going to do student-centered education, what better place than to have a student-centered measurement tool in place.

Mr. GALLAGHER. Yes. From our perspective, the first thing is great partners. I listed a number of them but the Joan Ganz Cooney Center has been an innovator in education for over 40 years. The MacArthur Foundation is extraordinarily dedicated to doing things that have an impact in the classroom. And from our perspective, our industry is very young and it is very action-oriented. We don't spend a lot of time talking about what we are doing; we spend a lot of time and energy doing it. So I would say the focus first on expert partners and leveraging their knowledge of how to judge success in the classroom from an innovation perspective not from an inertia perspective, which if the Members of the Committee, or Mr. Chairman, if you saw the movie *Waiting for Superman*, you can see the tremendous amount of inertia that is present in our education system. The partners that we work with have a reputation for being innovative and overcoming it.

Second, the focus is on the kids. It is on the learner, not on the teacher, and when the learners are engaged, you are going to get a better outcome, and we see that intuitively but both the MacArthur Foundation and the Joan Ganz Cooney Center have put out publications that point to the catalytic value of our industry in engaging children on this path, not just entertainment but of learn-

ing, and much like Mr. Norman said, it is embedded in the process. It is not something that is force fed to them.

And then we also make sure, or the partners look at how well the games not only are engaging but they are teaching the material. They also have wonderful assessment mechanisms. When you have a scoring process in a game, the kids are being tested as they are going through it and they don't even really know. It is just part of the experience, which also makes it fun and engaging.

And then finally, it has to scale because our goal is to develop solutions and exciting opportunities in the classroom that then can be spread throughout the country quickly because we don't want to waste another generation of children while these innovations—once they are ready, they should go immediately.

Ms. JOHNSON. Thank you. My time is expired.

Chairman HALL. The gentlelady has yielded back her time. Recognize the gentleman from California, Mr. Rohrabacher, for five minutes.

Mr. ROHRABACHER. Thank you very much, Mr. Chairman. Thank you for holding this hearing and calling these witnesses, and let us just note that our founding fathers held technology and innovation at a high level, high priority. Very few things were actually written into the Constitution but patent rights—you know, the word "right" was only put in the main body of the Constitution when talking about the right technology rights of an inventor or a writer, and of course, my favorite founding father was Benjamin Franklin, who of course Chairman Hall reminds a lot of Benjamin Franklin, meaning a very beloved man. I was comparing you to Benjamin Franklin, Mr. Chairman.

Chairman HALL. You know, we were in law school together.

Mr. ROHRABACHER. I thought so.

The significance today is we know and we have the same value on innovation. The American people place the same value on innovation and technology today. However, we are mired down in our society and we are being held back, and there are forces at play that are holding us back, and not the least of which is the failure of public education, which is mired now in bureaucracy and union roadblocks to excellence, and people in public education refusing to acknowledge that perhaps a science teacher might need to be paid more than a basket-weaving teacher or something like that. So those of you in the private sector are stepping forward, and I think this is a natural happenstance in America, and that is, the American people are stepping forward to correct a problem, and that is, we don't have the progress, and we call it STEM, but we don't have the progress in science and engineering and mathematics that we should among our young people.

I would like to first ask Ms. Conrad, in terms of your foundation, how do you—first of all, how do you pay for these awards and everything? You are not a government agency. How do you pay for your upkeep?

Mrs. CONRAD. Good news and bad news. The first two years, I funded the program. My children then said to me, mother, you are about to be put up for adoption, and the program got too big for me so that was the very good news of this. We raise our funds through partnerships with large corporations, for example, Lock-

heed Martin and PepsiCo and Kraft, and corporations of that nature who really understand and work with us as leaders in developing the innovative workforce for the future. I mean, we are growing their workforce. The amount of money that the students receive as the award for this competition—and we only—we don't do first, second and third, we do one winner per platform. This year we will be doing aerospace to create products for use in aerospace, energy to create products for use in energy, we don't care if it is renewable, storage or efficiency. We don't say make this and if you make it better than the next guy you win. We just say here is the problem, make whatever you want. And then this year we are going to challenge students in nutrition and ask them to help solve weight problems, specifically obesity and healthy lifestyles.

Mr. ROHRABACHER. Well, that is great.

Mrs. CONRAD. Yes. So they come up with things that are so out of the box, and we don't tell them there is a box, so they just jump right out and create amazing products.

The award that they get, we fund one team that wins in each category. We fund them sort of like venture capital. We "invest" in their product idea. Some of them have come up with such outstanding products that we help patent them if they need a patent, and then help them license their IP into the marketplace. The kids get a \$5,000 grant, and the grant is discretionary. It must be used to continue to develop their product idea. So the funding comes primarily—well, at this point almost solely from corporations that work with us. We also have had a discretionary grant—pardon me—an unsolicited grant from NASA Ames that has been very helpful to us, and NASA Ames has been tremendously supportive of our efforts.

Mr. ROHRABACHER. I think Pete would be very proud of everything you are doing and so I thank you very much.

Mrs. CONRAD. Thank you, Dana.

Chairman HALL. Thank you. The gentleman yields back and I now get to recognize the gentlelady from Maryland who sits just as far away to the right of me as she can sit. I recognize her for five minutes.

Ms. EDWARDS. Wow, Mr. Chairman. You know, you started out, Mr. Chairman, this morning saying that there weren't a lot of us here but I think it is important for us to recognize quality and not just quantity and so I am glad to be here with the Members of the Committee and also our witnesses and thank you very much for your testimony.

Among the occasional frustrations that I have here in this institution is that we are constantly insisting on either/or answers, responses to questions in a really dynamic world that is anything but either/or answers, and that is looking at STEM the relative role and responsibility of the Federal, State and local government of our private partners in developing this next generation so that it has the skill set to compete in the 21st century, and I think it is on all of us in each one of these sectors to do what it takes to develop that next generation, and I take it from your testimony that you share that.

I want to start with Mr. Norman because I do understand the value of STEM partnerships like yours. I know that we have

Project Lead the Way projects in my Congressional district in Prince Georges and Montgomery County just outside the city, but one of the things that strikes me is that it would be impossible to take advantage of the platform that you offer had it not been for federal grants and State grants and local support for the local school systems that are partners in those projects, that having the platform itself is not enough to engage students on an ongoing basis. We need the federal support that comes to our State and our local school systems to enable the resources and teachers to be able to effectively participate in those projects.

You talked—in your financial disclosure form, I notice that you did not mention that you actually have an active grant from NASA, for example. I am sure you have other—or maybe you have other federal grants and opportunities too and so the work that you are doing and the platforms that you provide aren't just reliant solely on the purview of the private sector. There is at least at some level a partnership with the Federal Government and so can you explain to us why you did pursue federal funding and what value that provides in your ability to develop these really innovative and creative programs for students around the country?

Mr. NORMAN. Absolutely. I guess the clarification I need to put in is, I am here representing Innovation First International, which has a company that is VEX Robotics that created this platform and finds those partners. The actual VEX Robotics competition is managed by another nonprofit called the Robotics Education and Competition Foundation. That foundation was created after years similar to Ms. Conrad where our self-funding was—it was getting overwhelming based on the size and the growth we had, and we thought the best way to actually be able to accept more donations from other corporations was to have that true 501(c)(3) backing us. So we have actually kind of handed the management off of that competition to that nonprofit. That nonprofit has gone and gotten some NASA grants, in fact, but it is an extreme minority compared to the corporate donations that exist.

Ms. EDWARDS. But I guess my point is, and I will go to Ms. Conrad and Mr. Gallagher as well, is that the things that you do, and I think they are really valuable and they are terrific and you reach students, but in order to reach your traditional public school student who, you know, may not come from a background that allows them to participate and all kinds of other limitations, wouldn't you agree that we do need the combination of the value that we get out of our scientific and research institutions along with what happens in the private sector?

I know in my community, NASA, Goddard, NIST, NOAA, these agencies are really unique partners along with our university community that receives federal funding that enables them to assist in our K–12 education. So the Federal Government and its agencies are not an aside to the work that we do; it is a partner. Isn't that correct?

Mrs. CONRAD. I would say that the partnership, and I will call it that, that we have with NASA has been extraordinary. It is not about funding necessarily but it is about support in terms of facilities and mentors and information and something that you can't put a number on but has tremendous value not only to the foundation

but to the students. I mean, our students, when they come to NASA Ames to do our innovation summit, they are so excited to be at a NASA facility, and Pete Warden comes and talks to the kids and it is very peer to peer, and it gives them a whole different perception of a government agency. It is much more inclusive and more dynamic and interesting and exciting for these young students. The Department of State is working very closely with us now, not necessarily having anything to do with money, but support and collaboration and partnership, and I think when you create new systems and you do it through collaboration and bring silos of excellence together with a strategic plan of actually growing a new system of education, then everyone can get in the sandbox together, so to speak, and actually drive the change that needs to happen from the point of view of collaboration, which may or may not include funding.

Ms. EDWARDS. Thank you. My time has run out.

Mr. Chairman, again, the point, though, is simply that whether it is resources or facilities and those things, those are resources, that is money also. It just doesn't come in the form of cash. Thank you very much, and I yield.

Chairman HALL. Thank you very much, Ms. Edwards.

The gentleman from Tennessee, Mr. Fleischmann, is recognized for five minutes.

Mr. FLEISCHMANN. Thank you, Mr. Chairman, and I want to thank the panel today. This is really incredible. I have enjoyed it very much. I represent the 3rd district of Tennessee, which has the Oak Ridge National Laboratory in it and Y12, so it is a very, very strong science centric district, and this is really helpful for me.

Mr. Gallagher, I have a question for you, sir. You testified that no federal dollar support is involved with your competitions. At the same time, the National STEM Video Game Challenge is touted as part of the President's Educate to Innovate initiative. Could you kindly detail for us how the two are connected and what the federal contribution is if it is not monetary, sir?

Mr. GALLAGHER. I am very pleased to take that question, and it is something that we are particularly proud of. When it comes to the role of the government, we see it on the front end as being the beacon of leadership, and then once we develop solutions, exciting tools for use in the classroom that they actually need to be implemented by government on the State level because that is where the rubber meets the road when it comes to education, so with the White House, there is a great enthusiasm for the ability of our industry to connect with youth on STEM-related issues and STEM opportunities. So we were put together with our partners through the leadership of the White House as part of an overarching leadership initiative that was not funded by federal funds. It is much more of a leadership exercise, and again, shining that beacon. And then we are in the process now, we are just going to start year two, will be announced this Friday in partnership with the White House again through the Department of Education. We intend to make that announcement with our partners. We are excited about taking the challenge to the next level. But when we have these modules, these units that are useful in the classroom, when those then need to be implemented, that is going to need to be done by the teachers

on the ground and it is through greater partners like Brain Pop that we would expect to see that happen.

Mr. FLEISCHMANN. Thank you very much.

Now I have got a question, and I will start with Mr. Norman and going across the panel. Do you all track the college or career paths of your competitors, and if so, what are you finding?

Mr. NORMAN. Not from the company side. From the foundation side, they are putting plans in place to try to help track that but at this time, you know, from the company side and the product side, we do not track that.

Mr. FLEISCHMANN. Mrs. Conrad?

Mrs. CONRAD. Yes, we are tracking it and we are watching our students enter STEM-related fields in college.

Mr. FLEISCHMANN. Okay. So there is a direct correlation between what you are doing and productivity on the other end?

Mrs. CONRAD. There seems to be, yes.

Mr. FLEISCHMANN. Excellent.

Mr. Gallagher?

Mr. GALLAGHER. Yes. Our experience as an industry is almost in reverse. There is such a huge demand within our industry for qualified STEM-educated workers that we look at the university system and we see that as where they are grown, and we just released a study, the Entertainment Software Association did, that counted 343 universities around the country that either offer a curriculum in video games or have degrees in video game technology. Twenty-four of them, Mr. Chairman and Ranking Member Johnson, are in the State of Texas, and I am proud to say that SMU, your alma mater, also offers a program that is focused upon video game excellence and going right into this workforce. So we are seeing it more from, we have a need and then let us grow it from the bottom up.

Mr. FLEISCHMANN. Thank you very much.

Mr. Chairman, I yield back, sir.

Chairman HALL. Thank you. The gentleman yields back. The gentlelady from Ohio, Mrs. Fudge, is recognized for five minutes.

Ms. FUDGE. Thank you very much, Mr. Chairman, and thank you all for being here. I just have a few very short questions.

First, if you could each just tell me in a program cycle or year, if that is your cycle, how many young people are involved in your program?

Mr. NORMAN. In the VEX Robotics competition, once again, there are several of the other partners that use out platform but just in the VEX Robotics competition, we were running right at 4,000 teams from schools, and teams range anywhere from five to 15 students per team.

Ms. FUDGE. Okay.

Mrs. CONRAD. Mr. Norman, we will take your overflow. We are very small. We are very young. We get about 600 teams coming into our competition right now.

Ms. FUDGE. Okay.

Mr. GALLAGHER. In the National STEM Video Game Challenge, we had 500 students compete in year one and then we will look to see that grow in year two.

Ms. FUDGE. Thank you. Now, let me ask, would all of you agree that all students need to have STEM education?

Mr. NORMAN. Absolutely.

Mrs. CONRAD. Absolutely.

Mr. GALLAGHER. I would agree, it is a top priority for students to have a grounding in STEM. However, our economy is diverse. Our needs as a country are quite broad and there may be a need for a broader range of skill sets.

Ms. FUDGE. I am not saying exclusively STEM.

Mr. GALLAGHER. Okay. All right. Very good. Yes.

Ms. FUDGE. Okay. Now, let me also say, and I appreciate Ms. Conrad's comment about, you know, how research and development in STEM fields have been the result of things like cures for diseases and how we send people to the moon, but I would say that we all need to recognize that most of that came as a result of government-funded research and development, and I think it is significant to say that.

Certainly as well, I think that it is important that all young people have an opportunity to not necessarily be involved in a competition but in fact to prepare themselves for jobs are going to be created in the next few years. I mean, there are some studies that say 80 percent of all new jobs in the next 20 years are going to come out of the STEM fields, so I think all young people need to have that opportunity.

Let me just ask a couple of very quick questions again. What functions of your program are enhanced by involvement with entities like public schools and that are funded and regulated by the Federal Government? My colleague tried to get to that issue. I want to just go back to it.

Mr. NORMAN. With public schools, once again, most of the funding for our program is a school partnering with a local business and not actually going and trying to find State or government funding. It is actually literally finding a corporation in their area and having them sponsor that—

Ms. FUDGE. I am not talking about funding. I said what functions. How do you interact with the public schools? Let me say it that way.

Mr. NORMAN. How do we interact?

Ms. FUDGE. Yes.

Mr. NORMAN. Well, I guess the biggest thing is the curriculum inside the classroom itself. I mean, it becomes a daily—the schools that have been the most successful and involved the longest, they actually create classrooms within the school, that is, actually the real robotics classroom—

Ms. FUDGE. Do they provide the teachers or educators? How does that work?

Mr. NORMAN. Well, we have a couple of partners. We have Carnegie Mellon University that creates curriculum. Intellitech is a for-profit company that creates curriculum. AutoDesk creates curriculum. And all of those together really help pull it to get it to the classroom. The most important thing, though, is getting the teachers trained, and that is where a lot of these same partners actually train the teachers.

Ms. FUDGE. They train the public school teachers?

Mr. NORMAN. Because teachers are scared of technology. Some of the teachers that have been in the workforce for a long time are scared of technology and you have to get them over that hump.

Ms. FUDGE. Okay. I just want to be sure. So these are public school teachers that are teaching?

Mr. NORMAN. Public school teachers.

Ms. FUDGE. Thank you.

Ms. Conrad?

Mrs. CONRAD. Thank you. Our entry into the school systems comes primarily through partnerships. We also partner with Project Lead the Way. We don't do curriculum and we don't teacher training. We have partnered with the National Science Teachers Association, which gives us access to a number of teachers who take our program in because it is an exciting way to bring STEM education into the classroom. So we are very much part of the in-class and after-school programs as well.

Ms. FUDGE. Great. Thank you.

Mr. Gallagher?

Mr. GALLAGHER. The function of public and private schools in our competition is principally to have the students that are available to compete, right, the 500 students that competed in the National STEM Challenge, so they spread the word, and partners like Brain Pop are actually an organization of 100,000 middle school teachers that then are told about the competition. The kids then organize and then bring the projects forward for judging and for potential award.

Ms. FUDGE. Okay. Thank you.

Mr. GALLAGHER. We also have the transmission mechanism at the end of the day will actually be through the schools themselves implementing these modules that are developed by these kids.

Ms. FUDGE. Thank you so much.

Mr. Chairman, I yield back.

Chairman HALL. The gentlelady yields back. The Chair recognizes Mr. Brooks, the gentleman from Alabama, for five minutes.

Mr. BROOKS. Thank you, Mr. Chairman. As a quick overview, I would note that the vast majority, in my judgment, of improvements in technology over the years have been because of the private sector where there is a profit incentive for people to excel. It might be new diagnostic tools in medical care. It might be new treatments in medical care. It might be technology, for instance, in the gaming industry with computer games or what have you. So our question here today is this additional bump that the Federal Government provides, what do we get for it and it is worth the cost in this time of budgetary issues that everybody in America is familiar with?

Now, that having been said as an overview, the Federal Government is spending more than \$3 billion a year to improve STEM education in this country. Mr. Gallagher mentions President Obama's goal of recruiting 10,000 STEM teachers and recruiting 10,000 engineers. In the 2007 *America COMPETES Act*, back when President George Bush was in office and the Democrats controlled the House and the Senate, Congress initiated a program to recruit 10,000 STEM teachers, so the President's idea is not exactly new.

Regardless, the Federal Government has been investing billions in STEM education for years, and the numbers do not seem to be improving dramatically. Is it a teacher issue, a subject-matter issue or something else? Are initiatives such as yours not only grasping students' attention but holding that attention and developing it into something more? Any of you all can volunteer any insights you may wish to share on the topics that I have just raised.

Mr. NORMAN. I guess basically what we pointed out earlier is it has to be fun, once again back to the Flintstones vitamin. Once they get engaged, they realize it is fun. And also once again partnering with these corporations within their community. You are putting these engineers and these inventors on a pedestal and you are basically creating someone that you want to be. It is just like everybody wants to be a quarterback of a football team. Well, when you are involved in these programs, you want to be that engineer that is designing and inventing the next toy or medical device coming out.

And as far as like, you know, basically—and going back to the NASA comment on funding on our program, it is my understanding that that funding is actually used as a recruiting tool for NASA for their future scientists and engineers to come work for NASA. It is really their recruiting program. It is not a hey, we are going to give money to just pump STEM. That is their—that is a lot of the program they are trying to push in there as well.

Mrs. CONRAD. You talked about better teachers and things of that nature and better schools. I think if we can look at education from a systems point of view and look at it that it is not just teachers or the technologies or the students or the parents or the building, it is really all of it, and I think what the private sector can do that perhaps is more nimble is to take that systems approach and bring all of those silos of excellence together to really drive something superior in the STEM education field because we are nimble and we can act quickly and we can respond to students and we can create student-centered education very quickly.

Mr. GALLAGHER. Congressman, I completely support the core challenge of your question is that we, as I stated in my opening testimony, face a crisis of making sure we have the STEM-educated workers we need to keep ourselves prosperous here in the United States and keep us in a leading position in the world, and that gap that is at the core of your question is precisely what motivates our interest in this subject. So while we are not federally funded for the efforts that we are undertaking and we are working aggressively to catalyze solutions, it is a bipartisan opportunity. It is a very, very important goal for us to tackle as a country, and we are much more focused about the solution instead of the cause, and we really want to develop those tools that are going to be useful in the classroom and ready immediately.

Mr. BROOKS. Let me have one follow-up question for whichever of you may want to answer. By way of background, my dad is an engineer, my two sons are engineers. My mom, my wife and my two daughters are teachers, my wife, a math teacher up until the time I got elected, very active in the STEM program in her middle school. There is a control issue. Where do you think the control of these STEM investments should be? At the Federal level, at the

State level, at the local school board level, in the private sector where you all tend to be? What do you recommend?

Mr. NORMAN. All of the above. No, actually, the local level for us seems to work better, and the reason I equate to that is from the standpoint of the corporations for us are the ones that provide the money, and the key to our program is finding that teacher that was willing to be a champion and go do this, and without that champion teacher, then you don't have that. Obviously, funding from the high levels would be a huge rocket for this program but we are building it in lieu of assuming we will never get funding from the government.

Mr. GALLAGHER. I would comment that it is go to the core competence of the actors that we are seeking to engage, and the Federal Government is really good at drawing large attention and having large projects that capture the imagination of kids and provide infrastructure, a pathway that they can understand or be excited by. The states are the ones that are the, remember I said before, the rubber meets the road, and that is where the implementation, the transmission mechanism has to happen. The private sector, we have a variety of tools at our disposal because of technology, because of the nature of our workplace. In my case, the engagement of our industry is that youth pay great attention. Each one has a core competence to add to an overall solution.

Mrs. CONRAD. I agree. I think that these smaller programs have the power to really drive impact where the government is looking for very large scale, very huge programs and it is all based on evidence-based education and numbers, and young programs such as the programs that Mr. Gallagher and I have, we don't have that large scale to get the funding that would be from the Federal Government or through the States right now. That will come. But we have the ability, as I said, to be nimble and to really drive something unique and exciting for these young students to get them engaged.

Mr. BROOKS. Well, thank you for your insight, and Mr. Chairman, it seems that I owe you 2 minutes.

Chairman HALL. Ms. Johnson says we will send you a bill.

The gentleman from Maryland, Mr. Sarbanes, is recognized for five minutes.

Mr. SARBANES. Thank you, Mr. Chairman. Thank you to the witnesses today.

I want to continue this theme about the partnerships between the Federal Government and the various initiatives that you are involved with and others, and Mr. Norman, you made a couple of statements that I would like to repeat because I think they are good ones. Early on, in response to a question, you said that any additional money that you can get for your program will help to accelerate the projects that you are involved in, and then you said just a moment ago that funding from high levels would be a huge rocket for your program, and I just—I want to emphasize that because Congresswoman Edwards introduced this subject of not getting stuck in an either/or kind of frame here, but really examining the full potential of partnerships to be developed between government and the private sector and ordinary citizens. I mean, I am sure your programs pull in a tremendous number of volunteers, in

a sense, who become as key an ingredient to the success of them as any of the more formal components are and so these partnerships have tremendous potential, and there has been some reference to the investment made by the Federal Government in STEM education, suggesting somehow that is maybe off base or more than it should be or something, and I think we should be very proud of that investment, and I think we should make good decisions about how that is going to be productive for our future. And I think your testimony, all of your testimony is consistent with that perspective, so I want to thank you for it.

Maybe if you could just each of you speak to it for a few more seconds on my time, I would be happy to have you do that, because in an environment where the imperative every day seems to be to cut back, we are at risk of undermining the kinds of partnerships that you are engaged in and can mean a great deal for our future and frankly they will pay us back in spades on investment in terms of the new inventions that will be generated and what it means for our competitive position around the world and for our economy. So I invite you to offer a few more comments on that if you like.

Mr. NORMAN. Yes, and I think it is important that when once again when you look at the private sector and look at donations from the private sector, as I said, a lot of it is what I consider recruiting for that company and giving back to their community. But the important thing is, is rather than if someone just—if every company involved with us just wrote a check, that wouldn't be impactful. Money is not that—it is taking their engineers and the people in their community and making them heroes and making them want to be that person and go to that person. So that is where it is a little bit different.

And when I say Federal funding would extremely help, you know, rocket I mean, I am looking at, you know, we can't afford enough teacher training. I would actually take the entrepreneurial way we built our company, which was I would market our program. I would market the program to the Nation and tell them what we are doing and try to get those companies to jump on board so that I didn't have to worry about that funding in the future.

Mrs. CONRAD. I think all of us face the funding monster every year, and it is an annual thing, and yes, government participation in programs such as ours would make a tremendous difference. I mean, in scale, we would go to the moon, if you will. So it would be really fantastic if government could see its way to including young, innovative programs such as the programs we have in their funding cycles. That would be fantastic. And as Mr. Norman said, what is incredibly important beyond and above and with that is the integration of government agencies with our programs, with our students in direct ways, even peer-to-peer ways.

Mr. SARBANES. Mr. Gallagher, let me jump in and ask you a different question because I am going to run out of time. Your industry has incredible influence over our young people, and you know, it can be for good, it can be for bad. It can—I don't think it can be neutral. I am convinced that one scenario for our future is that one day everyone will come home and play video games all night and then they will go back to work the next day and they will be

working at jobs creating video games and that will essentially be our economy and our world.

You know, I see all these devices, the Wii, the DS, the handheld—all these things that really consume the imagination of our kids, and what I am curious about is, are you all looking at how on the gaming side, think of what happens at home, what happens in the entertainment, as it were, leisure space of the next generation and how you can start to tease into that connections back to education, so we are not thinking about what happens in school, what happens at home but how to link those together.

Mr. GALLAGHER. Congressman Sarbanes, that is an excellent question, and the answer is yes, we are doing that and it is through the first partnership that we developed. It is a competition called Game Changer and the partnership focused on how do you take titles that are very popular with kids right now and add an education component to it because as Mr. Norman highlighted earlier, if you make it homework, they won't do it. If you make it boring or monotonous, then they tend to be distracted to go do other things. How do we capture the appeal of our industry and channel their energy in an area where they are learning without really thinking about it? And the two titles that our industry made available, which is very highly protected intellectual property but they said okay, we will open this up and make available. One is Little Big Planet, which was Game of the Year two years ago. That was made available by PlayStation. And the other was Spore, which was made available by Electronic Arts published by EA, and both of those games are very creative where the kids need to develop everything from physics and math to make the games work. They actually design their own worlds. They are doing that within a curriculum that is math-science based. So that is one example of what we are doing.

On the other competition, it is focused on a core principle. We believe that we should be developing a middle class not just of consumers but of creators, and by putting the tools in their hands like we saw in the opening video, you are seeing the kids create their own experience. In that process, they are learning and they are learning in a dynamic way that is going to be more applicable in the world that we are competing in today than where we were 50 years ago, which is unfortunately the classroom that they are sitting in.

Mr. SARBANES. Thank you, Mr. Chairman.

Chairman HALL. With good questions. Thank you, sir.

Now we recognize the gentleman from Arizona, Mr. Quayle. He is famous for one thing and that is that he is probably the youngest Chairman of a Subcommittee up here and his father is also famous for being the father of this youngest Chairman. I recognize Mr. Quayle for five minutes.

Mr. QUAYLE. Thank you, Mr. Chairman.

I want to kind of pose this to all of you, but I am from Phoenix, Arizona, and we have a really large and robust high-tech sector. We have a lot of engineers and mathematicians and a lot of big companies that rely on engineers. And one of the things that they keep telling me, they say look, the quality of the engineers and peo-

ple that are coming out are just as good as ever, but the quantity is just really low.

And one of the other things is that how are we going to really capture the imagination of young people to stay involved within math and science and engineering—and as we look at the graying of the workforce in the high-tech sector, especially amongst engineers, I have spoken to a lot of them who have said look, “I would really like to give back to my community and enter into the teaching profession.” The only problem is it is very difficult to get in and actually teach because of the licensing and the certification programs, and we have had people who tried to and were actually rebuffed after 20 or 30 years within the high-tech field. I think that we are losing out on some great practical experience, not just the fact that some of them have Ph.D.’s, but the practical applicability of math and science that could really look at kids saying hey, you know, if you take this algebra class and you take it seriously, if you take calculus and you take it seriously, these are the products that you get to make at the end of the day. So my question is, I know that licensing and certification is on the local level, the State and local level, and I want to keep it that way, but is there some way that we could have a flexible program, some sort of flexible accreditation that we could push and that we could really emphasize to make it easier for those that have the practical experience who want to get into the teaching profession, who want to give back to their community because that is giving back after they are retired. Do you think that that is feasible and do you think that there is a way to push that so that we don’t lose out on all this knowledge that is just sitting on the sidelines that wants to engage those young people but it is really difficult for them to get involved? I ask it to all three of you.

Mr. NORMAN. I will answer that briefly. I am not exactly sure how to make that type of certification happen but I will point back to that creating that, you know, community heroes we keep talking about, that mentorship so that kids want to become that. I think you are spot on by saying if we had that person from industry and could talk about what they did or what they accomplished in their career would obviously help push kids want to be that person rather than the basketball player or the football player. And we work with microchip very closely, too.

Mr. QUAYLE. Okay, great.

Mrs. CONRAD. My response to you is the following. We have a very close community of mentors that work constantly with our young teams of entrepreneurs and innovators, and this is really a place where people like the folks you are talking about can drive an immediate, robust, amazing impact with young people, which may not be the classroom but it certainly has great ROI for what I call the gray birds, and when you really look at mentorship, it is a circle. These gray birds are learning just as much from these students as the students are learning from their mentors. So I encourage you to think about the vast array of amazing minds that can pay it forward through mentorship and especially active mentorship programs such as the one we have.

Mr. QUAYLE. Before you answer, Mr. Gallagher, I think, Ms. Conrad, that one thing is that within the mentorship and within

those programs, you have to have the kid, the child, the student to actively pursue that whereas if it is in the teaching, they are in the classroom, and you might be hitting a kid who might not have even thought about that subject matter and then they just get inspired and then they pursue it long term and they are actually the future, you know, creators of Intel going forward.

Mrs. CONRAD. No, I agree with you and I think one of the really tremendous things that we are doing within our program and in our competition is active mentorship. It is really robust and there is a lot of people from companies and government agencies that are in there all the time mentoring our young students. So it is a way, it may not be the way, and there is a program, I believe, that Sherry Lansing created that brings—Sherry Lansing was Paramount Pictures. She has created a program to actually bring retired engineers and such back into the classroom and to offer training to them to enter the classroom.

Mr. QUAYLE. Okay. Great. Thank you.

Mr. Gallagher?

Mr. GALLAGHER. Thank you. Yes, three quick points. First, you are exactly right. The aspirational component of what our industry represents to kids mesmerizes them. You bring in a professional who actually has a very deep STEM education who is making video games, you put them in a classroom and the kids pay rapt attention. They are very focused on how do I be like you. And so those are types of flexibility we think is going to be necessary in the out years once we have these modules in place where the kids will then say all right, well, here is how I do it, now I have this lesson module that makes sense and these are more integrated as opposed to the separated nature that we have today.

The second thing that I would add is that Quest to Learn is an experimental school. It was started in New York and now has opened a second facility in Chicago. The entirety of the curriculum is taught through video games through their design and then through their playing and execution, and to demonstrate again that this can work, and it is going to take very novel approaches to take today's teaching corps and be able to expose them to those types of methods.

The third point that I would add is that that is being done in an aspirational manner by Sandra Day O'Connor, former Justice Sandra Day O'Connor, in partnership with Arizona State University. She has a game that she has developed called I Civics which was developed in 2009. There are now five games that teach kids civics through video games. So you can leverage all of these various pieces, put them together in a successful way.

Mr. QUAYLE. Great. Thank you very much.

Thank you, Mr. Chairman. I yield back.

Chairman HALL. The gentlelady from California, Ms. Lofgren, is recognized for five minutes.

Ms. LOFGREN. Well, thank you, Mr. Chairman, and thanks for this hearing. As always, sometimes the questions my colleagues ask, inspire as many questions in me as the witnesses themselves, and as I was listening to my colleague from Arizona, I was remembering William Shockley, who shared the Nobel Prize, coming and attempting to teach in my 9th-grade science class, and he was a

brilliant scientist but he was a disaster as a 9th-grade science teacher. So I do think, however, that engineers and scientists have a role sometimes in the classroom and I do think that there needs to be flexible certification but certainly as mentors and helpers.

And I have been, as I think most of us have been, to science extravaganzas. I know that Synopsys in particular in the valley has been very generous in funding science exhibitions. I remember I went to one this spring. It was, you know, 7:00 in the morning and it was East Side San José High School, so not the most advanced part of Silicon Valley, and it was thousands of kids who were just vibrating with excitement over the science fair, and I talked to one young man who was a junior who had done an experiment in nanotechnology carbon tubes and he had secured, with the assistance of a company, their electron microscope. I asked him, did it work? He said well, I don't know because the oven at the lab wouldn't get hot enough. So it is worth remembering that what we do in these wonderful events also relies on a properly funded school system. I mean, if you don't have a lab that works, it is not going to work.

One of the things I am interested in—in the valley, if you can't measure it, it doesn't exist—so I am interested in how we measure the outcomes, and obviously, you know, to have a thousand kids vibrating about science is better than a lot of other things they could be doing even if there is not a flow into better grades or better careers. But our goal is to do better than diverting kids from mischief. It is to actually improve their education and to get them into a better spot.

I just had a chance to read a report from the School of Education at the University of Pittsburgh indicating that in their analysis, the participation in robotics actually had no measurable positive impact in terms of academics. I don't know whether you all have the capacity—and this is my question, really—to connect up with the schools, be they charter, private or public, that are giving you your students to get the metrics measured both to see how they—and then also to fine-tune what you are doing so that the excitement also translates to academic achievement.

You know, I have seen kids at First Robotics, the big robotics in the valley where, you know, they are building something but they don't necessarily—they haven't learned anything about electrical engineering, they haven't learned anything about math. How do we collaborate with the wonderful work that you are doing with the actual academic world and how can there be feedback? What are the metrics and what would you need to make that happen?

Mr. NORMAN. Well, I guess from my standpoint, once again, I am more on the for-profit side, and as an entrepreneur, I measure my results based on what I see and what I feel, and that makes me run really fast. Funny enough, the person behind me is a teacher from San José that is the president of the REC Foundation and that is kind of his job to figure out how to measure that. But what we do see is story after story after story of schools with a less than 50 percent graduation rate, once this program goes into place we have seen them go all the way up to 100 percent before.

Ms. LOFGREN. So attendance is—you can measure attendance and that is good. Time on material, that is a good thing. Is there

any way to hook up like the test scores with the participants and get feedback from the academic world of what you are doing to fine-tune these———

Mr. NORMAN. I am sure there is. There is obviously a lot of privacy issues you deal with actually with kids and what you can and can't track. We had several brainstorming sessions of how to accomplish but that part of the issue of our success is we are growing at such a rapid rate, sometimes we are kind of the dog that caught the bus and it is, you know, resources.

Mrs. CONRAD. One of the things that we are teaching, so to speak, is design thinking skills, real out-of-the-box capabilities, a very difficult thing to measure at best. Having said that, that is just part of what we do so the design thinking skills are applied to product development, and as we see more products being developed and kids actually patenting and commercializing that product, there is a tremendous ROI not only to the students but to the world at large as these students solve these problems. As we grow and as we go and as we scale and measure more and more, I believe, like you, the juice factor is tremendous. Just getting kids excited to learn———

Ms. LOFGREN. Oh, no, I don't disagree with that. Having the excitement is valuable even if it doesn't result in a single increase in test scores but I am wondering, can we do better?

Mrs. CONRAD. Well, excuse me, Congresswoman, but is test score everything? From the point of view of are we serving the student by just giving them a test to measure what they have learned and how do you measure design thinking.

Ms. LOFGREN. You know, it depends—I guess one of the questions is, what are the metrics you want to look at.

Mrs. CONRAD. Exactly.

Ms. LOFGREN. And, you know, I am running out of time so I don't want to cut Mr. Gallagher off, but I am very interested and I don't think it is something that the Congress can do, but to see whether collaborating, maybe we can even do this at home to see are there some metrics certainly in the math arena—that is highly measurable—where we could help and really track performance, understanding that individual students have privacy but when you have a group you can get a group outcome as well.

Mrs. CONRAD. I think that is a great idea.

Ms. LOFGREN. Thank you.

Mr. GALLAGHER. Congresswoman, thank you for your leadership on so many issues in the technology sector, and in answer to your question, I would offer one example. On March 30th, we had an event here that was put on by the Atlantic, and it was purely focused on using video games in education and how do we that from end to end, from policy all the way through to practical results, and Connie Yao, who is a senior leader at the MacArthur Foundation, offered some thoughts along this line which I think are particularly valuable in answer to your question. She immediately states up front that she has no love for our industry, that she does not have a deep affection for technology. What she is motivated by is does what you are saying you are going to do work, period, and that is what she puts her effort behind, and her primary focus is exactly the focus of your question is assessment. She believes that cur-

rently we are not assessing students properly in the classroom, similar to Mrs. Conrad's thought, and that the video game environment provides instantaneous feedback. You know exactly how you are doing in that moment. It provides experimentation for learning to then occur and then there is a better learning process because the assessment is richer, deeper and produces a better student at the end of the day. I think that is what she would say if she was here. If I got it wrong, I know she will correct me.

Ms. LOFGREN. Good. Thank you very much, Mr. Chairman.

Chairman HALL. The gentlelady yields back. The gentleman from Texas, Mr. Smith, is recognized for five minutes.

Mr. SMITH. Thank you, Mr. Chairman.

Mr. Chairman, before I get to my questions for the panelists, I would like to mention that Mrs. Conrad in her discussion a while ago of mentoring reminded me of a personal experience, and I know I have mentioned it before but I think it has been a while, but it was one of the most satisfying experiences I have had in all my years with Congress even though it took place outside of the halls of Congress, and that is that a number of years ago I volunteered to tutor a student who might need help in the local school up here where I live in northern Virginia, and I was asked if I would tutor a young girl who was failing math, and I said well, I will certainly try. And this was a young girl who had all the stereotypes against her. She was from a broken family. Her mother didn't speak English very well. She lived in an apartment below a garage apartment that belonged to another family. And of course, there are sometimes the belief that girls don't like math. In any case, I, who didn't know what he was doing, tried my hand at tutoring for the very first time. At the end of the year, she ended up getting an "O" for outstanding in math and won a science award, and she is now in college and in fact was an intern in my office this summer. So it is nice to be able to have kept up with her over the years.

But from that personal experience, I took or learned a couple lessons. One was the importance of tutoring, particularly tutoring by those who really know what they are doing and how much that can be helpful, just a little bit of an extra effort perhaps outside a class or after school. The other is, I think it is important to catch—to try to influence students before they ever get to high school. You have to really have an interest in science and math before that or you are not going to be likely to take algebra as a freshman or calculus as a senior or whatever it is these days that we encourage our STEM-type students to do.

In the book—this is a stretch—in the book Boswell's Life of Samuel Johnson, Samuel Johnson is quoted as saying that much can be made of children if they are caught young enough, and I think that that is true when it comes to teaching them to enjoy the sciences or math or whatever it might be. You are welcome to comment on this, but as I say, what I took away from it is try to catch the children young, younger than high school, to provide mentoring and/or tutoring and you can really perhaps change some lives.

Let me ask my question to all the panelists, and you are welcome to respond to my lessons as well as my question, which is a little bit different, and this, Mr. Gallagher, plays off of a sentence in

your written testimony. You said that “the current unemployment crisis is not simply a jobs problem, it is a skills problem,” and I would like everyone to respond to that, but if you would start, Mr. Gallagher, I think that actually is connected to my experience which goes beyond jobs. It is teaching young people skills that they can use in jobs. And my understanding is that a lot of our companies today perhaps particularly the high-skill companies are not finding individuals with the skills that they need and unfortunately that goes back to what they might have learned or what they might have gotten excited about many, many, years ago. But Mr. Gallagher, if you will begin?

Mr. GALLAGHER. Thank you very much for the question, Congressman, and I appreciate your highlighting that one sentence because it is very, very indicative of the reality that our industry faces. Currently, Microsoft has openings, you know, they are looking for over 4,000 engineers or computer science majors, and they are working very hard to fill those positions, very hard to find and fill those jobs.

Mr. SMITH. I wasn't here earlier but I am familiar with and I am sure they were discussed how few graduates we are producing here in this country compared to the number of foreign students who are coming over to take those jobs, too.

Mr. GALLAGHER. That is a very significant contributing component to the gap. John Riccitello, who is the chief executive officer of Electronic Arts, will be here next week giving an address at the U.S. Chamber of Commerce, and he will be—one of the themes of his remarks will very likely focus on a passion of his, which is that we do have this skills gap where we have tremendous needs for highly compensated jobs. The average wage in my industry is over \$90,000 a year. Those jobs are highly sought after and very aggressively sought by those that are motivated in the STEM arena. However, the rest of the economy, there is a severe disconnect because of the competitive nature of the world economy.

Mr. SMITH. Thank you.

Mrs. Conrad?

Mrs. CONRAD. You know, I think it is unfortunate that we have diminished the skills that are out there in the workplace because I think if you kind of unwind the ball, at the core of that is that we don't have students who have a passion to learn. I call it the education Cuisinart where we put kids in there and we just stuff facts into their heads so that they can take a test instead of real-time assessment as they are going, education centered on the student rather than on a test so that there is continuous assessment, and if a kid is snagged up—and this is what Kahn Academy has done which is brilliant. If a kid is snagged up in algebra, they help him get past the snag so that they can move on, and that is really, I think, part of the thing that has impacted our system of education in such a very, very strong way that skilled workers, whether they are machinists or artisans or whatever they are, people aren't getting excited in the classroom anymore. It is not—as we talked about, Mr. Norman mentioned, yes, it is about fun but you have got to get the passion re-engaged in our young people so that we can increase the numbers and not sit around admiring our problem in education.

Mr. SMITH. Thank you, Mrs. Conrad.

Mr. Norman, I also noticed you developed a curriculum in regard to the robotics competition and so forth, and I think that could be helpful, but if you want to respond real quickly, my time is up.

Mr. NORMAN. I guess I have to hit the button first. There are several things that you mentioned. Recruiting is very, very important to all the workforce and that is why I think that companies that spend the money that they would normally spend in recruiting on a program such as this, they can help get that incentive for students to get involved in STEM and then also be ready for them when they come out.

A quick thing about the international. We deal a lot with international growth, and you would be amazed at how the foreign countries, specifically China, has realized that what they are missing—they create a lot of engineers and a lot of book-smart people but what they have been missing all along is innovation so they are highly endorsing these types of programs that are mentioned here at this table to actually push that innovation and get that different thought process and we are working closely with the governments of Mexico, Malaysia, China, you would be amazed at the push they are doing to try to get that step.

Mr. SMITH. We need to equal or better the push that other countries are making, I think. Thank you.

Thank you, Mr. Chairman.

Chairman HALL. Thank you.

The Chair recognizes Ms. Sewell, the gentlelady from Alabama.

Ms. SEWELL. Thank you, Mr. Chair, and I would like to thank all of our panelists for being here today and also to congratulate you on the success of your programs.

I wanted to address the issue of access. I represent Birmingham, Alabama, but I also represent nine very rural communities in Alabama, and the reality is, that we don't have private companies that have technology at their fingertips to help partner with our public schools or with schools in general there, and so there needs to be, I think, a concerted effort if America is to get back to number one in the STEM education field to really address the access issue. The reality is that my old high school only has four microscopes for a classroom of 30, so lack of resources and lack of access. And so I would like for each of you to address how you think we can get partners to see the value in developing the necessary infrastructure, if you will, to provide access to all of our children, not just those that are fortunate enough to live in Silicon Valley or California or places where there is a real community of science-related fields that can mentor them. What about rural America?

Mr. NORMAN. I think from what we have seen, I mean, it kind of comes down to the chicken and the egg. Once the program has started and the community sees what is happening, there is a big influx of support within the community where companies are giving \$200, \$300, you know, very small—and even families pitching in on this program. So where I think it is important to have not just a huge investment program where it is extremely expensive, thousands of dollars to participate. You know, we try to be as scalable as we can, and when you talk with some of the programs that

we are mentioning here, just getting some program started is the most important and then evolve to what you can get to.

Mrs. CONRAD. We had an experience in a rural environment in the Navajo Nation, and the teams came in about two years ago, one team, now it is like lots of teams, and because we are free and we are very user-friendly to all students, we are starting to grow a very big presence in terms of these sorts of communities. A third of our kids are inner-city kids. And my thinking is, it is not how smart are you, it is how much can you take what you know, stretch it and make something out of nothing and come into this group. The mentors come in through the communities where these children learn, and it is all starting to come together as a movement in innovation.

Ms. SEWELL. How can we promote more private companies to actually want to come to rural communities and partner with them?

Mrs. CONRAD. Well, the companies that we partner with partner across the board with us so we reach into the rural communities, the partners come with us.

Ms. SEWELL. How can we encourage you to come to Alabama?

Mrs. CONRAD. Just invite us.

Ms. SEWELL. You are invited.

Mr. GALLAGHER. Congresswoman, first a general thought and then a specific act, a thing that we are focusing on in regard to bringing the promise to rural America. First, we all need to leverage what is within our reach to deliver the STEM promise to all of America including the rural areas and that is the consistent theme is what is within our reach. With the tools that we see, first of all, you have almost universal penetration of personal computers, or PCs. You also have video game consoles, current-generation consoles in 70 percent of American households right now so those two factors mean that the tools are present. You connect them with broadband, which they are very important policies that both Congress and the Administration are pursuing to increase broadband penetration, it is in the homes of all the families including in the most rural areas.

Ms. SEWELL. Oh, yeah, Mr. Gallagher, you are definitely in all the homes in the rural areas. GameBoys are everywhere and people do use that. But how are you leveraging that, and your association leveraging that very critical resource that you have at your fingertips because—and moving and trying to penetrate those rural communities and step up the game when it comes to science and technology?

Mr. GALLAGHER. Well, there are two purposes of how that is done. One is driving the passion that Mrs. Conrad talks about, is to enlighten in these kids an excitement about a path. You motivate them and then they get over the hump on some of these STEM setbacks where it gets hard. That is one.

The second one specifically is that ESA has a foundation. The foundation awards grants competitively. One of them is to Globaloria, and Globaloria is now a nationwide program but it started in rural West Virginia and it is focused on taking video games and teaching children 21st century skills through video games, and we have a very productive partnership in the grant that was done through Globaloria.

Mr. NORMAN. I would like to add one last comment, if you don't mind. One of our partners, which I mentioned earlier in the testimony, the BEST program, Boosting Engineering, Science and Technology, they are actually a free program as well that gets people involved, and it is a good way to start out, and they are very active with Auburn University in your State.

Ms. SEWELL. Thank you.

Chairman HALL. The gentlelady yields back. The Chair recognizes the gentlelady from Illinois, Mrs. Biggert, for five minutes.

Mrs. BIGGERT. Thank you so much, Mr. Chairman, and thank you for holding this hearing today on STEM education, an issue that is very near and dear to my heart, and in addition to serving on the Science Committee, I also sit on the Education Committee where we are working to reauthorize the Elementary and Secondary Education Act, and as part of that effort I recently introduced a resolution, H.R. 378, and it is a bipartisan resolution expressing the sense of Congress that strong consideration be given to the role of science education in the educational accountability system in the next education reauthorization bill, and I introduced this because I believe that incorporating science and math in education is most critical and it is most critical now than ever. Recent studies showed that 21 percent of high school science departments have reported that the facilities presented a serious problem to science education and yet only eight percent of schools surveyed reported that there was a lack of student interest. And so that was a serious problem. So if we are to meet the future demands of the complex, diverse and competitive workforce, there is clearly a gap that we need to fulfill now.

My first question kind of goes along with what Ms. Sewell was talking about except that I was wondering if any of you are partnering with the local, regional or State governments on STEM activities. Mr. Norman?

Mr. NORMAN. Sure. Yes, we do, and in fact, one of the partners, which is Project Lead the Way that we are working very closely with, works directly with the State Board of Education and they actually from what I understand have a really close relationship there, and through that program we grow that program and other programs with it.

Mrs. BIGGERT. Thank you.

You know, we have got—within the Elementary and Secondary Act, grants are given only for the LEAs, those that are the teachers and the schools, and cannot be initiated by non-government entities, like for example the Museum of Science and Industry in Chicago is very interested in working with the schools and having the grants so that they can go to the different schools. Would you think that the STEM education would benefit from having these kind of grants being given to, you know, educational groups instead of just the schools, Ms. Conrad?

Mrs. CONRAD. Yes. Actually, when we built our program, part of the way we reached out to grow scale is through partnerships with museums and science centers. They have tremendous opportunity to bring community in to teach and to transfer information outward, so yes, I think that is a capital idea.

Mrs. BIGGERT. But it is making it very difficult without having the grants to be able to do that.

Mrs. CONRAD. Exactly, and it would be a tremendous effort if she can find a way to access that, not only into the museums and science centers but have that ability for the museums and science centers to work with folks like us, which we already do, and right now we have gotten to the place where we are now looking for some States and some groups of that nature that would work with us closely on that.

Mrs. BIGGERT. Well, look to Illinois.

Mrs. CONRAD. I love your Museum of Science.

Mrs. BIGGERT. And then secondly, Mr. Gallagher, I know that I didn't get to hear your testimony but I would welcome the feedback that you get and all of you the learning targets that have changed since the days of the Oregon Trail and Carmen San Diego, and I recognize the medium of games. I have nine grandchildren that are walking around with all these tools all the time and, you know, the desktop or the iPhone has expanded but has the complexity of potential skills expanded with that?

Mr. GALLAGHER. Congresswoman, that is a very good question, and we believe that the more immersive environments that our technology creates are critical for learning, how to do your job in the 21st century. You need to juggle many different components. You have to make multiple calculations. You have to do them quickly. You have to do them dynamically and you have to do them in three dimensions. That is not just how it is done inside of a game, it is how it is done in a competitive workforce as well. So we believe that in the right hands the tools that we have as an industry can be used to catalyze those same thought processes amongst kids in a very productive way and we also believe, and I emphasized this at the outset, it can be done now. The improvements that need to be taken need to be done now, not after we lose another generation of students that are not going to be competitive in the world marketplace.

Mrs. BIGGERT. Thank you. That is very interesting. Is there help for adults?

Mr. GALLAGHER. Yes, there is.

Mrs. BIGGERT. Thank you. I yield back.

Chairman HALL. I thank the gentlelady. The round of questions are completed obviously, and I thank the witnesses. The book on witnesses is that we invite people who know much more about the subject than we do, and from that we arrange our bills and legislation that we will later debate. I say this, we have had good questions today. I think you have given very abundant, good answers and I think you have been a very unusual group and I thank you very much.

The Members of the Committee might have additional questions for you, but I am going to quit talking. I am afraid some other Member is going to come in and want five minutes and it is right close to noon. But I thank all of you. We may ask you to respond to these questions in writing. They will do it within the next couple of weeks.

The witnesses are excused and this hearing is, with my gratitude to all three of you and to those who back you up, we are adjourned.

[Whereupon, at 12:02 p.m., the Committee was adjourned.]

Appendix I:

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Mr. Tony Norman, President and CEO of Innovation First International, Inc.

Questions submitted by Chairman Chairman Ralph M. Hall

Q1. Understanding that we are in the midst of difficult economic times and with severely limited resources, what role should the Federal government play in STEM education?

A1. A lot of success can be accomplished through public / private partnerships at the corporate level. That being said, in addition to the current investments put forth towards STEM Education, it would be beneficial to see the Federal government take action towards incentivizing school districts to adopt co-curricular robotics programs, and encourage teacher training programs that would fuel the awareness and integration of hands-on programs like VEX Robotics in classrooms across the nation. Any efforts the Federal government could take to identify industry mentors and innovation ambassadors that would communicate the benefits of programs like ours directly to their local constituents would be great. Lastly, the Federal government could take new measures to connect with America's large corporations and show them how their investment in programs like ours leads to workforce development.

All of these suggestions would help ensure that the most hands-on STEM based programs that excite and motivate students to pursue STEM degrees in college and careers in STEM fields, become accessible to as many schools as possible, to as many students as possible, in as many cities and states as possible.

Q2. What makes VEX Robotics different from other programs available today? What does it take to accelerate growth and reach more students with this program and what barriers do you face in achieving this accelerated growth?

A2. VEX Robotics is the only middle and high school robotics platform with significant penetration in both the daytime classroom instruction and extracurricular competitions. VEX Robotics was designed for education, architected for competition, and cost engineered for scalability. VEX attracts students that wouldn't have ordinarily had a previous interest in science and technology, and because it is affordable, VEX reaches underserved student populations and improves the diversity of those students interested in STEM.

Most robotics programs that are offered today end at high school, are costly, and solely focused on after-school competition, and rely heavily on engineers from industry partners to volunteer their time. VEX Robotics addresses this issue by dramatically lowering the cost of participation for schools and students, by extending beyond high school through to college, and by involving higher participation and support from parents and teachers as mentors—because we want robotics to motivate students to go beyond high school—we want robotics to show students that they can all become top STEM professionals.

To accelerate growth and reach more students with this program we need to get more corporations to invest and join forces with VEX Robotics, we need more teachers to become champions of robotics in the classroom which leads to more teacher training, and we need more school districts to encourage schools and teachers to adopt VEX in the classroom.

Potential barriers that we face in achieving accelerated growth boils down to incentives, teacher / mentor training, school resources and credentials—all of which would help fuel both mentor and teacher involvement.

Q3. You testify that your robotics competition is the only one that provides in-classroom training and out of classroom experiences. Please tell me more about the in-classroom experience. How are schools incorporating this into their curriculum? Is it offered as a separate elective or made part of another class?

A3. We testified that VEX Robotics Design System is the only platform that was designed specifically for classroom and extracurricular use. How schools incorporate VEX into the in-classroom experience varies on a case-by-case basis. At some schools you will find teachers incorporate VEX into their engineering, math, or science classes. Other schools will work to establish a separate robotics class using VEX hardware, creating their own curriculum, or utilizing one of our curriculum partners such as Autodesk, Intelitek and Carnegie Mellon University Robotics Academy. Other ways you will find VEX incorporated into the classroom is through some of our other partners and curriculum providers including *Project Lead the Way*, Tech-

nology Student Association or Da Vinci Minds. As you can see, there are various entry points for VEX entering into the classroom setting.

Q4. VEX Robotics Competition is an international competition. What distinguishes American students from their international counterparts?

A4. Aside from technical language barriers, once students reach the stage of a VEX Robotics Competition—they all get a chance to operate on a level playing field. Certain teams will have a superior robot, others will be better strategists, some will be better on-the-spot problem solvers, and others will be better communicators. Other than that there truly aren't many major distinguishing characteristics between the American and the international students, except for the age factor. Each year we see an increasing number of younger kids coming to compete from China and Australia as their governments have prioritized VEX in the classroom which in result has fueled their success and growth.

Responses by Mrs. Nancy Conrad, Chairman and Founder of the Conrad Foundation

Questions submitted by Chairman Chairman Ralph M. Hall

Q1. Understanding that we are in the midst of difficult economic times and with severely limited resources, what role should the Federal government play in STEM education?

A1. We believe it is vital for our nation's leaders to understand the imperative to educate and prepare our children to be at the forefront of STEM education, technology and industry. It is our opinion that establishing new federal policies is not the answer. Federal efforts should include thought leadership, allotting resources for research and providing funding to supplement activities undertaken by states and independent organizations focused on innovative and evidence-based STEM programming.

In addition, special attention should be paid to the nation's STEM educators and to developing funding mechanisms to help supplement the out-of-pocket costs often incurred by these instructors.

It would be beneficial to the STEM movement to have a database that served as a unified resource for jobs, internships, career preparation, grants and research funding specifically for the fields of science, technology, engineering and math.

Q2. You testified that one third of your competitors are women, one third from underserved groups, and one third from students who enter multiple competitions. Is this by design, or is this just the way the applications came in? If by design, how are you reaching out to women and underserved populations? How do these individual groups do in the competition? Is the breakdown of winners similar?

A2. We put extra effort into nurturing relationships and creating Champion Partnerships with organizations capable of promoting our program to girls and underserved populations. Organizations such as the National Girls Collaborative Project and Girl Scouts of America make our program available as a resource to their communities. This year, 33 percent of our participants are girls.

Our program is available at no cost to all participants, making it a viable program for low socioeconomic student populations. To increase our reach to this underserved population, we developed relationships with school districts in Los Angeles, Philadelphia, Houston and San Francisco to specifically involve their larger communities of low-socioeconomic populations in the program. In addition, several teams from the Navajo Nations have been active participants in our program. Many of these Navajo students are from very private communities, making their public participation in the program all the more significant.

Last year's winning teams came from across the country and represented a broad spectrum of racial and economic diversity. While one-third of the total challenge participants were girls, they performed exceptionally well in the overall competition with 42 percent of the winning participants being girls. Of the five winning teams, two teams were comprised entirely of female team members.

Q3. Who mentors the students on the business side of things? Who helps them with the patents and how many patents have been secured by competitors since the inception of the Spirit of Innovation Awards?

A3. We provide students with mentors from different professional membership societies, such as Sigma Xi, the American Institute of Aeronautics and Astronautics, and the American Society for Nutrition. Each year, their membership provides both technical and business expertise for the students. Our partners at NASA, Lockheed Martine and PepsiCo also encourage their workforce to interact with the students to provide their professional guidance and to share their STEM knowledge. We are often independently approached by other experienced entrepreneurs who offer their unique expertise to our students.

The Conrad Foundation's Board of Directors offers a sub-committee called the Portal comprised of intellectual property lawyers and entrepreneurs who help selected teams file and secure patents of their own. At this time, three patents have resulted in this program.

Responses by Mr. Michael D. Gallagher, President and CEO of Entertainment Software Association

Questions submitted by Chairman Chairman Ralph M. Hall

Q1. Understanding that we are in the midst of difficult economic times and with severely limited resources, what role should the federal government play in STEM education?

A1. STEM education is key to rekindling America's global economic competitiveness, yet at present we face a critical STEM skills shortage. The United States must educate and develop its own talent supply for the 21st century ideas-based economy.

However, due to the resource limitations referenced in the question, it is critical that each level of government fund and stimulate precisely those elements of STEM education spending within their core competence. As I underscored in my testimony at the hearing, the Federal government is particularly strong on the "big infrastructure" items like NASA, NIST, and other areas of large, national scope research. And, states and local governments are much more strongly enabled in the classrooms themselves, as well as the educational efforts that historically have been provided by state and local governments.

That said, the federal government can be effective in this regard in the following four ways:

1. The federal government should focus on having executive agencies collect assessment data and other evidence that focuses on the effectiveness (for whom, how, and under which conditions) of STEM education.
2. The federal government should encourage the adoption of technology in the classroom to ensure that student engagement on STEM education maps to 21st Century workforce skills such as systems thinking, critical analysis, problem solving, computational abilities, collaboration, and creativity. The single best way to achieve this objective is to capture the imagination of students on the "big dreams" of our time—similar to the space program of the 1960s and 70s.
3. The federal government should concentrate on stimulating private sector innovation in STEM learning. The federal role in encouraging R&D is essential to sort out the conditions under which STEM education will be most powerful, especially for underserved students.
 - a. For instance, federal agencies can incent public-private partnerships such as those supported by the Small Business Innovative Research (SBIR) grant competitions that are already underway. These competitions can create enticement for small companies to develop digital games, mobile applications and other technology enabled innovation to support STEM learning. In some cases, federal funding in these areas could be tied to relaxing state regulatory requirements for teaching certificates for professionals with proven expertise in areas both interesting to students and valuable to our country.
4. Finally, coordinating national funding priorities for STEM across agencies should not be overlooked by the federal government. Education is not just K-12; it extends to professional development, job skill training, and career retooling. With this in mind, millions of dollars are being spent by agencies on direct training and human capital development programs at the U.S. Department of Education, SBA, NASA, and the Department of Defense that could be coherently prioritized and coordinated for the benefit of students, teachers, and product designers.

Q2. What do we know about how students and the general public learn from digital learning environment? What don't we know? How can we effectively evaluate this type of learning environment?

A2. There have been numerous recent analyses and planning reports on the use of digital learning to advance national educational and technology infrastructure priorities. In recent years, there have been four federally supported analyses:

1. The National Education Technology Plan issued by the U.S. Department of Education in 2010 concluded that our schools are in fundamental need of modernization—from new technology infrastructure to a complete "re-conceptualization of professional development," which relies far more heavily on networked communications technologies.

- a. A prime example of this modernization is Quest to Learn, a New York City public school grounded in principles of game design, the first of its kind. The New York Times recently described the philosophy of Quest to Learn and Katie Salen, its founder, “at its best, game design can be an interdisciplinary exercise involving math, writing, art, computer programming, deductive reasoning and critical thinking skills.” (<http://www.nytimes.com/2010/09/19/magazine/19video-t.html>)
2. The role of games and simulations in science education was the subject of an independent scholarly review by the National Academy of Sciences in 2010. The NAS found promising evidence that digital simulations can significantly advance children’s science learning. (<http://ebookey.org/Learning-Science-Through-Computer-Games-and-Simulations1223289.html>)
3. A review of educational technology-enabled curriculum programs issued in 2009 by the GAO for the U.S. Department of Education found only limited evidence that a randomized control design of student learning on standardized measurements was advanced by technology-oriented curricula. (<http://www2.ed.gov/about/offices/list/opepd/ppss/reports.html#edtech>)
4. An independent review of evidence and a research plan by the National Science Foundation on cyberlearning in 2008 (<http://www.nsf.gov/pubs/2008/nsf08204/index.jsp>) found digital advances have the potential to transform STEM learning in the decade ahead. The research states, “Cyberlearning offers new learning and educational approaches and the possibility of redistributing learning experiences over time and space, beyond the classroom and throughout a lifetime.” However, without deliberate efforts to coordinate cyberlearning approaches, we will miss the opportunity to provide effective support for the convergence of learning and technology.

Taken together, these reports indicate the promise of digital tools and new approaches to embedding digital learning in U.S. classrooms has not yet been fulfilled, and that further experimentation is an urgent national priority. The federal government (both Congress and the Executive Branch) should help raise the profile and importance of the 21st Century cluster of skills outlined above. This emphasis would help drive research dollars, new modes of assessment, and public-private partnerships toward more innovative products and services in digital learning.