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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…

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…

VEX Robotics, Inc., is 10 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 extracurricular 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 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 US.

- **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 odes 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, engineering 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.

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