HEAD HEALTH CHALLENGE: PREVENTING HEAD TRAUMA FROM FOOTBALL FIELD TO SHOP FLOOR TO BATTLEFIELD

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FIFTEENTH CONGRESS

FIRST SESSION

DECEMBER 13, 2017

Serial No. 115–42

Printed for the use of the Committee on Science, Space, and Technology

Available via the World Wide Web: http://science.house.gov

U.S. GOVERNMENT PUBLISHING OFFICE
28–412PDF WASHINGTON : 2018

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December 13, 2017

HEAD HEALTH CHALLENGE: PREVENTING HEAD TRAUMA FROM FOOTBALL FIELD TO SHOP FLOOR TO BATTLEFIELD

Wednesday, December 13, 2017

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 10:07 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Barbara Comstock [Chairwoman of the Subcommittee] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

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RANKING MEMBER

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House of Representatives
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Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield

Wednesday, December 13, 2017
10:00 a.m.
2318 Rayburn House Office Building

Witnesses

Dr. Michael Fasolka, Acting Director, Material Measurement Lab, NIST

Mr. Scott A. Kebschull, Vice President and Technical Director, Dynamic Research, Inc.

Dr. Alex O. Dehgan, Chief Executive Officer and Founder, Conservation X Labs

Mr. Shawn Springs, Chief Executive Officer, Windpact

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

HEARING CHARTER

December 13, 2017

TO: Members, Subcommittee on Research and Technology

FROM: Majority Staff, Committee on Science, Space, and Technology

SUBJECT: Research and Technology Subcommittee Hearing:
"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

The Subcommittee on Research and Technology of the Committee on Science, Space, and Technology will hold a hearing titled *Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield* on Wednesday, December 13, 2017 at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose:

The purpose of the hearing is to review this science prize competition and its goal of spurring the development of advanced materials that will improve the performance of protective equipment not only for athletes, but also first responders, military personnel and others who face head injury from impact events.[1]

Witness List

- **Dr. Michael Fasolka**, Acting Director, Material Measurement Lab, NIST
- **Mr. Scott A. Kebschull**, Vice President and Technical Director, Dynamic Research, Inc.
- **Dr. Alex O. Dehgan**, Chief Executive Officer and Founder, Conservation X Labs
- **Mr. Shawn Springs**, Chief Executive Officer, Windpact

Staff Contact

For questions related to the hearing, please contact Cliff Shannon of the Majority Staff at 202-225-6371.

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[1] https://www.nist.gov/news-events/news/2017/09/nist-nfl-ge-and-under-armour-announce-dynamic-research-and-6d-helmets-grand

Chairwoman COMSTOCK. The Committee on Science, Space, and Technology will come to order. Without objection, the Chair is authorized to declare recesses of the Committee at any time.

Good morning, and welcome to today's hearing entitled "Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield."

I now recognize Chairman Smith, who has another hearing right now, to give his statement first as he has another obligation in Judiciary Committee that he needs to get to. Chairman Smith.

Chairman SMITH. Yes, I appreciate your recognizing me out of order. I do have to shuttle between hearings, so that will be helpful.

And thank you to Chairwoman Comstock for holding today's hearing.

The Science Committee has a longstanding, bipartisan interest in the use of science prizes and challenge competitions to address difficult national problems. *The American Innovation and Competitiveness Act*, signed into law in January of this year, included provisions from our Committee that streamlined and improved how federal agencies participate in science prize competitions.

Our Committee is particularly supportive of the Head Health Challenge due to the involvement of the National Institute of Standards and Technology, or NIST, over which this Committee has jurisdiction. NIST has been a leader among federal science agencies in challenge prizes and science competitions, including private-public and multi-agency initiatives.

Science prizes aren't new. At a Science Committee hearing last Congress, curators from the Smithsonian brought the original $25,000 prize check earned by Charles Lindbergh for his solo, nonstop flight from New York to Paris in 1927. At the time, Lindbergh's daring feat and the $25,000 prize attracted a lot of attention. But few people understood what we know today, that Lindbergh's achievement launched the age of aviation and the aerospace industry.

Scientific prizes and challenges are proven approaches for spurring innovation and solving problems. As we will hear this morning, collaboration between the federal government and the private sector adds credibility and is often the best way to trigger breakthroughs.

Our witnesses will tell us about the final phase of the Head Health Challenge, a challenge prize sponsored by NIST, the National Football League, Under Armour, and General Electric. The objective of this challenge is to accelerate the design and development of advanced materials for helmets, pads and other products that protect against head injuries.

Better design and materials for helmets and other protective gear can reduce head injury risk in many occupations. These include all sports and at all levels of competition, head—high-risk jobs like construction, manufacturing, and forestry, first responders, frail elderly individuals and, importantly, our American soldiers.

DOD estimates that 22 percent of combat casualties from the conflicts in Iraq and Afghanistan involved brain injuries, compared to 12 percent of Vietnam-related combat casualties. Improved hel-

met protection is one of the best steps we can take as a nation to improve the quality of life for our military veterans.

Preventing or minimizing head injuries is also an important public health and safety issue for children on bicycles, for amateur and professional athletes, for fire and police personnel, and for men and women of all ages and all walks of life. I look forward to hearing from our witnesses about the success of the Head Health Challenge and yield back.

[The prepared statement of Chairman Smith follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
December 13, 2017

Media Contacts: Thea McDonald, Brandon VerVelde
(202) 225-6371

Statement from Lamar Smith (R-Texas)

Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield

Chairman Smith: The Science Committee has a longstanding, bipartisan interest in the use of science prizes and challenge competitions to address difficult national problems.

The American Innovation and Competitiveness Act, signed into law in January of this year, included provisions from our committee that streamlined and improved how federal agencies participate in science prize competitions.

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The objective of this challenge is to accelerate the design and development of advanced materials for helmets, pads and other products that protect against head injuries.

Better design and materials for helmets and other protective gear can reduce head injury risks in many occupations: these include all sports and at all levels of competition, high-risk jobs like construction, manufacturing, and forestry, first responders, frail elderly individuals and, importantly, our American soldiers.

DOD estimates that 22 percent of combat casualties from the conflicts in Iraq and Afghanistan involved brain injuries, compared to 12 percent of Vietnam-related combat casualties. Improved helmet protection is one of the best steps we can take as a nation to improve the quality of life for our military veterans.

Preventing or minimizing head injuries is also an important public health and safety issue for children on bicycles, for amateur and professional athletes, for fire and police personnel and for men and women of all ages and all walks of life.

I look forward to hearing from our witnesses about the success of the Head Health Challenge.

###

Chairwoman COMSTOCK. Thank you, Mr. Chairman.

And I now recognize Mr. Lipinski for five minutes.

Mr. LIPINSKI. Thank you, Chairwoman Comstock, for holding this hearing, and thank you to our witnesses for being here today.

Prizes and other types of challenges have proven to be valuable tools to advance research and technological innovation to help solve some of today's biggest social and economic problems, including head injuries.

Under the Obama Administration, the federal government's use of prizes and challenges increased exponentially, and we've heard that the current Administration is likewise interested in maximizing the use of such competitions.

It is important for this Committee to periodically examine federal agencies' use of prizes authority, so I'm pleased that we're having this hearing this morning.

Since World War II, the United States has become a leader in advancing science and innovation thanks in large part to long-term commitment of the federal government to research and development. Today, grants, contracts, and cooperative agreements form the cornerstone of government support for R&D. While these traditional research financing mechanisms continue to be critical, they also require a big upfront investment with no guarantee of success.

For certain types of scientific and technological problems, prize competitions and challenges can stimulate major breakthroughs with little to no risk to the taxpayer. Science prizes and challenges, whether cash prizes or nonmonetary awards, incentivize creative approaches to bold but achievable goals. Early prize competitions dared inventors to do the unthinkable: to fly over the Atlantic Ocean, to determine longitude for accurate ship navigation, and to preserve food to feed an army on the battlefield. Achieving bold goals requires bold thinkers, and prize competitions and challenges often attract participants who do not typically seek government grants or contracts. The nation's advancement and innovation depends on thought leaders with a diversity of ideas and experience.

I have long supported the use of prizes to promote the advancement of emerging technologies. I co-authored the H–Prize Act which became law in 2007. It has given the Department of Energy authority to conduct prize challenges for development of hydrogen as a transportation fuel. I also introduced a bill to provide prize authority to The National Science Foundation and supported the 2010 COMPETES reauthorization provision that provided broad prize authority to all federal agencies.

And I'm soon going to be introducing a bill called the Challenges and Prizes for Climate Act, which will establish new prize competitions overseen by the Department of Energy to work toward breakthroughs in clean energy technology development and implementation and climate change adaptation and mitigation. I urge my colleagues to look at this bill and to consider co-sponsorship.

One hundred federal agencies have offered 800 prizes since the launch of Challenge.gov in 2010. The NIST Head Health Challenge III is one such example, and I believe it may serve as a model for public-private collaboration in the development and implementation of a prize competition. As the witnesses describe their experience in the Head Health Challenge, I hope they'll leave us with

their thoughts on how this challenge has changed the protective gear industry, why it was successful, and what if anything they might have improved in the design or implementation of the challenge. I also look forward to hearing what next steps are planned and underway to take advantage of the lessons learned and technological advances made during the three Head Health Challenges.

Ensuring that the attention and excitement generated by challenge is effectively channeled into action upon its conclusion is one of the hardest parts of running an effective challenge, and I look forward to hearing from our witnesses their best ideas for doing that.

I also look forward to Dr. Dehgan's testimony about his work launching USAID's global challenges for development and his current work to facilitate public-private partnerships for prizes and challenges. I believe he will help us understand the types of problems that are best solved through open innovation and some of the cutting-edge new ways prizes and challenges are being used. I also look forward to hearing his thoughts on how federal prize competitions and challenges best fit in the government's broader R&D portfolio.

Thank you, Madam Chairman. I look forward to hearing from the witnesses this morning, and I yield back.

[The prepared statement of Mr. Lipinski follows:]

OPENING STATEMENT

Ranking Member Daniel W. Lipinski (D-IL)
of the Subcommittee on Research & Technology

House Committee on Science, Space, and Technology
"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"
December 13, 2017

Thank you Chairwoman Comstock for holding this hearing and thank you to the witnesses for being here. Prizes and other types of challenges have proven to be valuable tools to advance research and technological innovation to help solve some of today's biggest social and economic problems, including head injuries. Under the Obama Administration, the federal government's use of prizes and challenges increased exponentially and we've heard that the current administration is likewise interested in maximizing the use of such competitions. It is important for this Committee to periodically examine federal agencies' use of prize authority, so I am pleased we are having this hearing this morning.

Since World War II, the U.S. has become a leader in advancing science and innovation thanks in large part to the long-term commitment of the federal government to research and development. Today, grants, contracts, and cooperative agreements form the cornerstone of the government's support for R&D. While these traditional research financing mechanisms continue to be critical, they also require a big up-front investment with no guarantee of success. For certain types of scientific and technological problems, prize competitions and challenges can stimulate major breakthroughs with little to no risk to the taxpayer.

Science prizes and challenges, whether cash prizes or non-monetary awards, incentivize creative approaches to bold but achievable goals. Early prize competitions dared inventors to do the unthinkable: to fly over the Atlantic Ocean; to determine longitude for accurate ship navigation; and to preserve food to feed an army on a battlefield. Achieving bold goals requires bold thinkers, and prize competitions and challenges often attract participants who do not typically seek government grants or contracts. The nation's advancement in innovation depends on thought leaders with a diversity of ideas and experience.

I have long supported the use of prizes to promote the advancement of emerging technologies. I co-authored the H-Prize Act which became law in 2007 and has given the Department of Energy authority to conduct prize challenges for the development of hydrogen as a transportation fuel. I also introduced a bill to provide prize authority to the National Science Foundation and supported the 2010 COMPETES reauthorization provision that provided broad prize authority to all federal agencies. And I will soon be introducing a new bill called the Challenges and Prizes for Climate Act, which will establish new prize competitions, overseen by the Department of Energy, to work toward breakthroughs in clean energy technology development and implementation, and climate change adaptation and mitigation. I urge my colleagues to look at this bill and to consider cosponsoring.

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Thank you Madam Chair. I yield back.

Chairwoman COMSTOCK. Thank you. And I now recognize myself for a five minute opening statement.

The purpose of this morning's hearing is to review the results of the final phase of the Head Health Challenge, a significant public-private collaboration for public health and safety. This worthy event is cosponsored by the National Institute of Standards and Technology (NIST) and three private organizations: the National Football League, General Electric Corporation and Under Armour, Inc. The final phase of the Head Health Challenge is aimed at design and development of advanced materials to improve protective equipment and prevent head injuries in sports, industry, the military and others who are at a higher risk of head trauma.

As a mom of three children who did play sports, the boys played football, my daughter played soccer, baseball—and I think we covered all the sports among the three of them—but now with five grandchildren, I really appreciate all of the work you're doing. It'll just be great for our children, as well as for our warriors and for our professional—I mean, there's just—this covers so many areas, so I'm just really excited about what you're doing for our entire community.

These kinds of public-private science challenges have a long history of catalyzing innovation and creating solutions to difficult problems. For instance, the Longitude Prize of 1714, offered by the British Government, resulted in the marine chronometer and dramatically improved shipping safety. Napoleon Bonaparte's 1800 Food Preservation Prize led to development of canned foods.

More recently, spurred by the clean-up problems after the Deepwater Horizon disaster in 2009, the Wendy Schmidt Oil Cleanup X CHALLENGE of $1 million demonstrated a technology that had more than four times the previous recovery rate for cleaning oil off the ocean's surface.

In recent years, NIST and other federal agencies have organized and/or supported prize competitions and challenges that ranged from accelerating the development of autonomous vehicles to breakthroughs in facial recognition technology. NIST and other federal agencies are involved in a number of multi-agency and private-public challenge initiatives, for which I congratulate them.

As my colleagues know, provisions of the *American Innovation and Competitiveness Act*, which originated in this Subcommittee, streamline prize competition procedures for federal science agencies and encourage them to consider them to stimulate problem-solving innovation. There is no shortage of priority research areas for which federal agencies should consider using prizes in the future. Health issues are at the top of my list because there is the potential to save many lives and also save huge sums of taxpayer money, as well as protect the quality of life in so many different areas.

At the last hearing on this subject, subcommittee members and our witnesses discussed the potential for catalyzing development of portable dialysis devices. A breakthrough in portable dialysis would improve hundreds of thousands of lives and could save Medicare billions of dollars every year and again obviously improve the quality of life.

Another terrible disease for which a public-private challenge prize might be considered is Alzheimer's disease. More than five

million Americans live with Alzheimer's today, and that total could triple by 2050 if there aren't breakthroughs in prevention and treatments.

Through support for basic research, through support for measurement science, through support for commercialization of taxpayer-funded research breakthroughs, and through science prize competitions, the top priority of the Science Committee is to encourage innovation and technological breakthroughs and advancements.

Initiatives like the Head Health Challenge encourage individual incentive and inspire creative solutions. They leverage significant private sector investments in important national priorities, for instance, preventing serious head injuries. And they engage the brightest and most creative minds our nation has.

We look forward to hearing from some of those best and brightest minds this morning, including Shawn Springs from Windpact, Inc., which is located in the 10th Congressional District of Virginia that I am proud to represent. I hope the stories of all our witnesses will help to inspire a new generation of scientists and entrepreneurs.

[The prepared statement of Chairwoman Comstock follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
December 13, 2017

Media Contacts: Thea McDonald, Brandon VerVelde
(202) 225-6371

Statement from Barbara Comstock (R-Va.)

Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield

Chairwoman Comstock: The purpose of this morning's hearing is to review the results of the final phase of the Head Health Challenge, a significant public-private collaboration for public health and safety.

This worthy effort is cosponsored by the National Institute of Standards and Technology – NIST – and three private organizations: the National Football League, General Electric Corporation and Under Armour. The final phase of the Head Health Challenge is aimed at design and development of advanced materials to improve protective equipment and prevent head injuries in sports, industry, the military and others who are at higher risks of head trauma.

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We look forward to hearing from some of those best and brightest minds this morning, including Shawn Springs from Windpact Inc, which is located in the 10th Congressional district of Virginia that I represent. I hope the stories of all our witnesses will help to inspire a new generation of scientists and entrepreneurs.

###

Chairwoman COMSTOCK. And I now recognize Mrs. Johnson, the Ranking Member, for her opening statement.

Ms. JOHNSON. Thank you very much, and good morning. I'd like to thank Chairwoman Comstock and Ranking Member Lipinski for holding today's hearing on the NIST Head Health Challenge and the benefits and challenges of federal prize competitions. I support the federal government's use of prizes and challenges to spur innovation and technology breakthroughs.

However, I want to begin with a brief comment about our larger commitment to research and development. I am deeply troubled that so many of our colleagues would support a tax bill that adds $1 trillion or more to the deficit while helping only the wealthiest among us and at the same time repeatedly vote to cut funding for research and so many other critical investments in our future. Many of my colleagues would even make it impossible for any but the wealthiest Americans to pursue graduate degrees in STEM because of proposed changes to the tax law.

While tough choices have to be made, and I am confident the overwhelming majority of my colleagues on my side of the aisle are willing to have those discussions, cuts to our federal R&D enterprise weakens the country's ability to be a leader in innovation, economic growth, and job creation. No corporate tax cut will fix that. Our competitors have the same tough budget choices to make, yet they are not just maintaining their R&D investments but increasing them.

While prizes and other types of challenges are not a substitute for the sustained investment in long-term national outlook that traditional federal R&D funding provides, they do have a role in how the government funds R&D. The prize authority granted to all federal agencies in 2010 COMPETES reauthorization stimulated a significant increase in agencies' use of such competitions of incentives, more high-risk, high-reward research. Prizes also help agencies to reach out to a broader partnership of researchers and innovators across all areas of science and technology. I'm encouraged by indications that the current Administration will continue support for prize competitions.

With several years of experience to build out—to build on, there are many lessons learned on how to best design and implement successful prize initiatives. There's also a new category of prize design expertise both in the government and the private sector. The NIST Head Health Challenge III appears to be a good model for public-private partnership and for the use of a challenge competition to spur innovation that had largely stalled. I look forward to hearing from NIST and the participants in this challenge about what worked well and how any lessons learned might be applied to future challenges. I also look forward to a broader discussion on how best to incorporate prizes into our broader federal R&D agenda.

I thank all of our witnesses for being here, and I yield back. Thank you.

[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT
Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space, and Technology
Subcommittee on Research & Technology
"Head Health Challenge:
Preventing Head Trauma from Football Field to Shop Floor to Battlefield"
December 13, 2017

Good morning, I would like to thank Chairwoman Comstock and Ranking Member Lipinski for holding today's hearing on the NIST Head Health Challenge and the benefits and challenges of federal prize competitions.

I support the federal government's use of prizes and challenges to spur innovation and technology breakthroughs. However, I want to begin with a brief comment about our larger commitment to research and development. I am deeply troubled that so many of my colleagues would support a tax bill that adds a trillion or more to the deficit while helping only the wealthiest among us, and at the same time repeatedly vote to cut funding for research and so many other critical investments in our future. Many of my colleagues would even make it impossible for any but the wealthiest Americans to pursue graduate degrees in STEM because of the proposed changes to the tax law.

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applied to future challenges. I also look forward to a broader discussion of how best to incorporate prizes into our broader federal R&D agenda.

I thank our witnesses for their testimony and I yield back.

Chairwoman COMSTOCK. I will now introduce our witnesses. Our first witness today is Dr. Michael—am I going to get this—Fasolka, okay, Acting Director of the Material Measurement Lab at NIST. MML, one of the seven research laboratories within NIST, did all the measurements and testing for the Head Health Challenge. This challenge was NIST's first prize competition conducted under the *America COMPETES Act* of 2010.

We should also note that the *American Innovation and Competitiveness Act*, which was signed in the law in January 2017, included a number of provisions that originated in our Committee that are named in encouraging more activity like NIST co-sponsorship of the Head Health Challenge. Dr. Fasolka has held his current position since 2012 and is responsible for strategic planning, communications, and operations for the lab. He received a Bachelor's of Arts in Liberal Studies from the University of Pittsburgh and his Ph.D. in Material Science and Engineering from MIT.

Now, our second witness today is Mr. Scott Kebschull, Vice President and Technical Director of Dynamic Research, Inc., DRI. He has been with DRI for over 30 years primarily working on crashworthiness and occupant protection for passenger cars, motorcycles, and off-road vehicles. He is an expert in multi-body and finite element computer simulation, the work that resulted in the team's winning of the Head Health Challenge grand prize. He holds a Bachelor's of Science in Mechanical Engineering from Valparaiso University and a Master's of Science degree in Mechanical Engineering from the University of Southern California.

Dr. Alex Dehgan, our third witness, is Chief Executive Officer and Founder of Conservation X Labs. He recently served as the Chief Scientist at the U.S. Agency for International Development where he was the architect of a number of new agency institutions, including the Grand Challenges for Development program, which used prizes to open innovation and address the biggest emerging global challenges. To date, USAID has launched nine Grand Challenges for Development. Dr. Dehgan earned a Bachelor's of Science from Duke University, as well as a Master's of Science and a Ph.D. from the University of Chicago. He also holds a J.D. from the University of California Hastings.

Now, Mr. Shawn Springs, our final witness, is Chief Executive Officer of Windpact, a northern-Virginia-based safety technology company that I'm proud to have in the 10th District of Virginia that is leveraging its patented padding technology to improve impact performance in helmets and protective gear. Windpact participated in certain Head Health Challenge competitions resulting in a first-place victory in the 1st and Future competition, as well as an award under the HeadHealthTECH II challenge.

From 1997 to 2010, Mr. Springs played football professionally for the Seattle Seahawks, the Washington Redskins, and the New England Patriots. It is that unique experience that he really brings a full range of experience, and also being a dad I'm sure, and I really appreciate your engagement on this issue.

He holds a Bachelor's of Science in Sociology from Ohio State University, and while playing for the Seahawks, Mr. Springs continued his education by attending the University of Washington,

where he was inducted into the Society of National Collegiate Scholars.

So I now recognize Dr. Fasolka for five minutes to present his testimony.

TESTIMONY OF DR. MICHAEL FASOLKA,
ACTING DIRECTOR, MATERIAL MEASUREMENT LAB, NIST

Dr. FASOLKA. Good morning, and thank you for inviting me today. Before I begin my testimony, we have a short video about the Head Health Challenge III.

[Video shown.]

Chairwoman COMSTOCK. Thank you so much. As a mom who would just wince at all those things as you see them on the field and everywhere else, it's exciting. And please, you don't have to take that out of your five minutes, so go ahead.

Dr. FASOLKA. Chairman Smith, Ranking Member Johnson, Chairwoman Comstock, Ranking Member Lipinski, and members of the subcommittee, thank you for the opportunity to discuss NIST's role in the Head Health Challenge III, which advanced the materials used in protective gear and help small companies mature ideas into marketable products.

Thank you for your attention to the video, which was made in 2015 when the semifinalists were announced. I'm pleased to testify today, along with the challenge grand prize winners who were named this past September.

NIST helps to ensure the U.S. system of measurements is firmly grounded in sound scientific and technical principles. The Head Health Challenge III is just one example of how NIST measurement science helps industry overcome barriers to developing new products and to manufacture them efficiently and reliably.

While NIST has a long history of inspiring solutions to difficult problems using challenges, this was our first offer of cash prizes through a public-private partnership. The Head Health Challenge III is just one aspect of the larger Head Health Initiative launched by GE and the National Football League in 2013 to quote, "accelerate concussion research, diagnosis, and treatment." NIST and Under Armour joined with GE and the NFL on this challenge to spur development of improved impact-resistant materials. As you saw in the video NIST's role was to act as a neutral provider of various technical results for the challenge.

One of the barriers to innovation in helmet design has been the lack of data of how well new materials absorb forces. More and better materials data helps manufacturers understand if developing a product with new material will result in improved performance. It is especially difficult to test how materials perform in real-world conditions such as when they are compressed, flexed, on a playing field, or in combat.

Small and medium-size companies may not have the resources to develop such types of facilities, so for this challenge we build on NIST expertise and measurements of body armor for law enforcement to make new instruments for materials testing. We also created a method to measure the forces exerted on the material by a rotational—also called shear—impacts which are under-evaluated in today's protective gear.

Many of the participants in this challenge said that they benefited from having their candidate materials assessed by NIST's new instruments. We tested the finalists' materials under a broad range of conditions: impact forces range from those seen in youth leagues to professional sports; test temperatures range from freezing to a hot summers day; and when we executed what might be a full season's worth of impacts about 20—1,200 hits. A panel of independent experts from industry, academia, and government evaluated the competitors' written proposals, their materials, along with the NIST test data to choose a winner.

A collaborative team, Dynamic Research and 6D Helmets, clinched the grand prize of $500,000 provided by NIST. Their material reduces some impact measures by nearly 80 percent compared to the benchmark materials we examined and helps reduce the transmission of rotational forces.

Beyond the prize money, the Head Health Challenge III generated terabytes of test data, which allowed some of the participants to inform computer models of how their materials respond to impacts. To serve the broader community, we will release to the public the data generated from our tests of the nonproprietary baseline materials we used. In addition, our new measurement capabilities will provide data for a materials genome approach to impact-resistant systems so that more people can benefit from higher-performing materials sooner.

Since the launch of Head Health Challenge III, NIST has announced more prize competitions at the Challenge.gov website. We also established a NIST-wide community interested in using these mechanisms to further our mission. We greatly appreciate the efforts of the Members of this Committee and other Members of Congress to support federal agency use of prize competitions and challenges. Thank you very much.

[The prepared statement of Dr. Fasolka follows:]

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Testimony of

Michael J. Fasolka
Acting Director, Material Measurement Laboratory
National Institute of Standards and Technology
United States Department of Commerce

Before the

Committee on Science, Space, and Technology
Subcommittee on Research and Technology
United States House of Representatives

"Head Health Challenge:
Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

December 13, 2017

Introduction

Chairwoman Comstock, Ranking Member Lipinski, and Members of the Committee, I am Mike Fasolka, Acting Director of the Material Measurement Lab at the Department of Commerce's National Institute of Standards and Technology (NIST). Thank you for the opportunity to appear before you today to discuss our role in the Head Health Challenge III (Challenge), which has helped spur innovation in the development of protective gear for athletes, warfighters, and civilians. This Challenge gained the attention of a diverse set of scientists and engineers and supported small companies seeking to transform these innovations into marketable products. The NIST laboratory programs work at the frontiers of measurement science to ensure that the U.S. system of measurements is firmly grounded on sound scientific and technical principles. Today, the NIST laboratories address increasingly complex measurement challenges, ranging from the very small such as nanoscale devices to the very large like vehicles and buildings, and from the physical as in renewable energy sources to the virtual world of cybersecurity and cloud computing. As new technologies are developed and evolve, NIST's measurement research and services remain central to innovation, productivity, trade, and public safety.

NIST and Challenges

NIST has a long history of using challenges to bring a community together to solve ambitious problems in support of the NIST mission which is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. In the early 1970's, for example, NIST issued a public challenge to develop a data encryption standard[1] to support computer security. Today, many decades later, a challenge is underway with NIST's Post-Quantum Cryptography Project[2] that asks developers to propose new algorithms that will meet security needs in the quantum computing era. Another example is the Global City Teams Challenge,[3] an ongoing effort by NIST to encourage collaboration and the development of standards for the deployment of smart technologies in cities and communities.

Head Health Challenge III was NIST's first prize competition conducted under the "prize competitions" authority in Section 105 of the America COMPETES Reauthorization Act of 2010 (Public Law 111-358), subsequently amended by Section 401 of the American Innovation and Competitiveness Act of 2016 (Public Law 114-329), and codified in 15 U.S.C. 3719. Prize competitions authority allows NIST to offer cash prizes, and further paves the path to partner with private sector for-profit and nonprofit entities as well as appoint judges from outside of NIST, including the private sector. Since the launch of the Head Health Challenge III, NIST has announced many more prize competitions under the prize competitions authority which can be found on the Federal government prize and challenge competitions web portal, www.challenge.gov/list/, and established an institute-wide community of interest in using prizes and challenges to further our mission. NIST greatly appreciates the efforts of the members of

[1] https://www.nist.gov/sites/default/files/documents/2017/05/09/report01-2.pdf
[2] http://csrc.nist.gov/groups/ST/post-quantum-crypto/
[3] https://www.nist.gov/el/cyber-physical-systems/smart-americaglobal-cities

this Committee and other members of Congress to support Federal agency use of prize competitions and challenges.

NIST and the Head Health Challenge

NIST and Under Armour joined with GE and the NFL on Head Health Challenge III with the goal of spurring the creation of innovative impact absorbing materials that will result in increased protection for athletes, warfighters, and civilians. The Challenge partners understood that the experts who could produce better materials could be found in a hugely diverse set of communities, from aerospace to automotive to sports medicine. The national prize competition sought to advance research and technology development in this field by gaining the attention of a wide network of materials scientists and others with an interest in answering this call to action. Together, the Challenge partners decided to reward designers with up to $2 million in prizes to develop or find existing materials that offer improved protection from impacts.

NIST was asked to become a partner in Head Health Challenge III because of its long history of finding new ways of measuring known substances and systems with ever more precision and accuracy, and creating ways of characterizing novel substances and systems for the first time. Participating in the Head Health Challenge III leveraged NIST's technical expertise and allowed NIST to do what it does best—conduct measurement science that helps industries overcome barriers to developing new products and manufacture them efficiently and reliably. As you'll soon hear, the Head Health Challenge III has assisted the participants in these ways.

NIST Measurement Expertise

One of the barriers to innovation in helmet design has been a lack of data about how well new substances absorb the force of hits to the head. Improved data helps helmet manufacturers understand if the risk of developing and manufacturing a helmet with a new material will give them an advantage over their competitors in terms of performance.

It is particularly difficult to test how materials perform in real-world conditions, such as when they are compressed and flexed by the forces of a hit on a playing field or a blast in combat. Small and medium-sized companies often don't have the capital to develop in-house testing facilities or pay for testing, or the in-house expertise to develop new test methods. NIST's participation in Head Health Challenge III helps provide the community with this testing infrastructure. NIST has a long history of producing best-in-the-world materials science measurements, and working with the private sector to help define industry parameters for protective helmets and body armor for law enforcement through private-sector led standards.

Building on these capabilities, NIST applied its technical expertise to build materials testing instruments in the laboratory and even created a new test in support of the Head Health Challenge III, explained below. As NIST learned during the competition, one of the major benefits reported by participants was the opportunity to have their materials assessed by NIST experts.

Head Health Challenge III

Head Health Challenge III asked entrants: "*Can your material withstand a force range of up to 12 kilonewtons, with the potential to withstand 1,200 impacts above 20 KE (J), and perform in the impact velocity range of 3.4 m/s to 11.2 m/s, and in temperatures ranging from 0 to 40 degrees Celsius, with up to 100 percent humidity*?" These parameters translate into real-world use: a broad range of impact conditions from youth leagues to the highest level of professional sports, temperature extremes from freezing to a hot summer day, and a year's worth of repeated impacts. NIST worked closely with the partners at Under Armour, the NFL, and GE throughout the past two years of this challenge to set the technical requirements and overall vision. During phase two of Head Health Challenge III, NIST acted as a neutral third party, generating rigorous technical results. A panel of independent judges, appointed by the NIST Director, made all decisions about the finalists and the grand prize winner. This panel of judges, listed below, represented unique and world-class materials expertise from industry, academia, and the Federal government.

- Jeff Crandall, Ph.D., Professor in Engineering and Applied Sciences at the University of Virginia;
- Sharon Glotzer, Ph.D., Professor of Chemical Engineering at the University of Michigan;
- Heinrich Jaeger, Ph.D., Professor of Physics at the University of Chicago;
- Michael Maher, Program Manager for the Defense Sciences Offices at the Defense Advanced Research Projects Agency (DARPA);
- Tresa Pollock, Ph.D., Chair of the Materials Department at the University of California – Santa Barbara;
- Alton D. Romig, Ph.D., Executive Officer of the National Academy of Engineering and former vice president and general manager of Advanced Development Programs Engineering and Advanced Systems, known as Skunk Works, for Lockheed Martin Aeronautics; and
- Alan Taub, Ph.D., Professor of Materials Science and Engineering at the University of Michigan.

NIST is grateful for the time and commitment of this group of individuals who played a critical role in achieving the ambitious goals set by the Head Health Challenge III.

The Challenge was structured in three phases with awards made in the first and final rounds of the competition.

> First, NIST invited participants to submit an abstract that described a novel material that met specific performance criteria related to maximizing energy absorption while minimizing momentum transfer. Subject Matter Experts evaluated 125 abstracts submitted by participants against the submission evaluation criteria and then invited authors of the 55 top-rated abstracts to submit more detailed proposals with samples of the material.

Next, a panel of judges selected five finalists to receive $250,000 in the First Round and the opportunity to compete for the grand prize of $500,000 in the Final Round. From the full proposals, 21 materials selected by Subject Matter Experts underwent mechanical testing at NIST. The judges evaluated the written proposals and, very importantly, the test results generated by NIST.

NIST's experts conducted a series of impact and compression tests on each sample, as well as on some conventional impact absorbing materials currently used in helmets to establish a baseline. While NIST had the necessary measurement infrastructure on hand because of its existing work supporting the development of improved test methods for ballistic- and stab-resistant body armor, NIST performed a considerable amount of customization to its equipment to subject the materials to the impact energies and velocities that have been reported in different sports and defined in protective equipment standards. NIST's capabilities include sophisticated features like instrumented impact systems and autonomous controls that generate smaller variations in the conditions from test to test. In the measurement science world, this means that it's more meaningful to compare test results from one material to another using NIST's equipment. Variations in results can be more safely ascribed to differences in performance rather than to margins of error in the tests. In December 2015, NIST announced the five First Round winners selected by the judges to move on to the Final Round. They included teams from academic institutions as well as businesses:

- Alba Technic, LLC (Winthrop, Maine) developed a patented, shock-absorbent honeycomb material with an outer layer that diverts the energy from a fall or hit;
- Charles Owen Inc. (Lincolnton, Ga.) made cellular structures that use a stacked, origami-like design to optimize energy absorption;
- Corsair Innovations (Plymouth, Mass.) developed a textile that uses tiny, spring-like fibers to repel rotational and linear impacts, thereby reducing potential damage;
- Dynamic Research Inc. (Torrance, Calif.) and 6D Helmets LLC collaborated to evolve 6D's single-impact suspension technology for use in repeated impact conditions; and
- University of Michigan (Ann Arbor, Mich.) researchers designed a lightweight, multi-layered composite that includes a viscoelastic material.

In addition to receiving a cash prize of $250,000, the finalists received the technical data generated by NIST and advice from the judges to direct the continued development of their materials for the final phase of testing.

Finally, the finalist teams were given about a year to improve their materials for consideration for the grand prize, $500,000. Between March and December 2016, the finalists submitted samples of their materials to NIST for a variety of testing. First, the samples were compressed between two instrumented plates to measure how they compress and rebound, using increasing amounts of force, through three cycles of testing. Second, NIST performed drop testing with an instrumented impactor to measure how

materials respond to sudden impact, progressing through five steps of increasing energy. NIST researchers also performed these tests at 0 degrees Celsius (freezing) and 40 degrees Celsius (104 degrees Fahrenheit). Third, to measure durability, the NIST researchers repeatedly performed drop tests on samples from each competitor 1,200 times before running additional impact tests on them. Importantly, in addition to the regimen described above, NIST developed a fourth, new type of test. A common injury-causing impact is rotational; imagine a glancing blow to the side of the head that sends the head swiveling on the neck. These kinds of hits cause the brain to rotate within the skull, damaging delicate tissues. Inside a helmet that has taken a glancing blow, material is undergoing both compression and shear—the kinds of forces exerted when you press your palms together and one of them slips. When NIST partnered in the Head Health Challenge III, there were only limited approaches to measuring these forces at the same time at high rates, so NIST developed a new method.

Head Health Challenge III Results

After the final testing round, the judges evaluated each Head Health Challenge III participant on innovation, material performance, degree of improvement during the Challenge, and commercialization potential, emphasizing creativity over product maturity.

In September 2017, NIST announced that a team of materials designers led by Dynamic Research, Inc. was the Head Health Challenge III grand prize winner. The Dynamic Research team has received $500,000 to help them progress their product toward commercialization. The team, which includes members from 6D Helmets, used advanced computer modeling and a series of iterative improvements to create a novel material, based on a 6D Helmet proprietary technology, with an unusual geometric structure. The winning entry reduced certain measures of impact by more than 70 percent when compared with baseline foam material that has been commonly used in protective gear, and the material's middle layer of absorbent posts sandwiched between foam helps reduce the shear forces that can cause rotational injuries. The winning concept also can be fine-tuned to a variety of impact environments and adapted to different body types and applications.

Benefits of the Head Health Challenge III

The Head Health Challenge yielded benefits for all involved.

Through the Challenge, NIST saw dramatic technical advances in how well a material can absorb impact. Some of the materials tested reduced the force of an impact by up to 80 percent, compared to conventional materials. The incidence of concussions and severe brain injuries can be significantly reduced with advances like that.

The many measurements performed at NIST amounted to terabytes of data, including high-speed video of samples as they were compressed. Between the first and second phases of testing, some of the contestants used the data provided by NIST to inform computer models of how their

materials might respond to impacts, or to verify models they had made themselves. To help encourage further material design improvements, NIST intends to release to the public large amounts of data generated from tests on the conventional baseline materials.

Computer modelling is used increasingly in materials development to predict performance before developers spend time and money making an actual material. This approach is promoted throughout many industries. It is supported by infrastructure being developed by the Federal government's multi-agency Materials Genome Initiative, which has the goal of bringing new materials to the marketplace faster than traditional trial-and-error invention. Currently, the materials genome approach is more commonly used for new metal alloys than for soft materials like shock-absorbing foams. NIST foresees that its new measurement capabilities for soft materials will provide data for predictive computer modelling, accelerating research and development of soft-materials so that more people will benefit from higher-performing materials, sooner.

The finalists reported that they have benefitted from their participation in the Head Health Challenge III in many ways. For example, they found they could adjust material to meet a wide variety of impact scenarios, making it possible to expand into new product lines and markets. They attracted commercial partners for further development of their material and integration into helmets and pads for further testing. Participants also reported that they integrated their novel material into an existing product. They verified that industrial 3D printing, also known as additive manufacturing, could be used to make their novel material, which will be incorporated into a new product. They also worked with a major materials manufacturer to develop and combine materials for optimum performance, now with patents pending.

This work demonstrated that there is significant opportunity to develop new designs and techniques for testing the performance of soft materials used in protective gear and other applications. What NIST has learned from testing will help inform future standards for the performance of such gear. NIST's new testing device, developed for this challenge, has already provided valuable data to the Head Health Challenge III participants, and will enable the development of future standards for new generations of protective equipment for athletes, first responders, soldiers, and others.

NIST is proud to have partnered with the NFL, Under Armour, and GE in Head Health Challenge III. Such a public-private partnership approach can leverage the best the public and private sectors have to offer, to solve pressing problems that would be hard for any one group to solve on its own. NIST was honored to have been recognized for its efforts with an award for "Public/Private Partnership Collaboration" by the General Services Administration (GSA) in GSA's first-ever Five Years of Excellence in Federal Challenge and Prize Competition Awards.[4]

Thank you for the opportunity to testify today. I would be happy to answer any questions you may have.

[4] https://www.challenge.gov/challenge-gov-celebrates-five-years-of-open-innovation/

Michael J. Fasolka

Michael Fasolka is Deputy Director and Acting Director of the Material Measurement Laboratory (MML), at the National Institute of Standards and Technology (NIST). MML, one of seven research laboratories within NIST, has nearly 1,000 Federal employees and guest researchers from industry, universities, and foreign laboratories.

MML provides a measurement science and standards infrastructure for the nation's industries based in the biological, chemical and materials sciences, promoting U.S. innovation and industrial competitiveness in ways that enhance economic security and improve our quality of life. MML is a source of unbiased measurement standards, data, and cutting-edge methods and technologies that promote innovation, market readiness, and quality control in vital economic sectors.

MML develops measurement standards in the form of documented measurement methods and instrument calibrations, and coordinates the NIST-wide Standard Reference Material® and Standard Reference Data programs. MML provides more than 1,200 Standard Reference Materials that ensure the accuracy of millions of measurements vital for efficient manufacturing, acceptance of American-made goods in international markets, regulatory approval of new technologies and medical treatments, and consumer confidence.

In his role of Deputy Director of MML, Dr. Fasolka is responsible for strategic planning, strategic communications, and operations for the laboratory. He has held this position since 2012. Previously at NIST, Dr. Fasolka has been a Senior Scientific Advisor or Deputy to several NIST laboratory Directors. From 2005 to 2010, Dr. Fasolka was Director of the NIST Combinatorial Methods Center and Leader of a Combinatorial Methods Research Group, established to provide industry with guidance and tools for the high throughput discovery of polymers and other soft materials. Before that, he was a Staff Scientist conducting research in polymer self-assembly and advanced scanning probe microscopy techniques. Dr. Fasolka received his doctorate degree in polymer science from MIT in 2000.

Education

Ph.D. in Materials Science and Engineering from Massachusetts Institute of Technology

B.A. in Liberal Studies from the University of Pittsburgh

Dr. Michael Fasolka Video:

Title: *Head Health Challenge III: Semifinalists Selected*

Published By: National Institute of Standards and Technology

Date: September 6, 2017

https://www.nist.gov/news-events/news/2017/09/nist-nfl-ge-and-under-armour-announce-dynamic-research-and-6d-helmets-grand

Chairwoman COMSTOCK. Thank you. Mr. Kebschull.

TESTIMONY OF MR. SCOTT A. KEBSCHULL,
VICE PRESIDENT AND TECHNICAL DIRECTOR,
DYNAMIC RESEARCH, INC.

Mr. KEBSCHULL. Good morning. My name is Scott Kebschull. I am Vice President and Technical Director of Dynamic Research, Inc., of Torrance, California. I want to thank Chairwoman Comstock, Ranking Member Lipinski, Chairman Smith, Ranking Member Johnson, and fellow members of the Subcommittee on Research and Technology for the opportunity to speak to you today about the Head Health Challenge III.

My company, DRI, partnered with 6D Helmets for the Head Health Challenge III prize competition to develop a material suitable for use in football helmets or other protective equipment that can better protect against traumatic brain injury. DRI is primarily involved in automotive research and testing, as well as helmet research and testing. 6D Helmets designs and manufactures helmets for bicycle and motorcycle riders that uses their patented omnidirectional suspension technology. 6D's role in this project was to provide the intellectual property and to fabricate the material samples for testing, and DRI's role was to manage the project, develop the simulation models, and optimize the geometry and material characteristics.

Football helmets with foam liners have been around since the 1950s. With the latest helmets available on the market, fatal head injuries are rare, but concussions still occur frequently. Traditional helmet liners are made out of monolithic blocks of foam. When these blocks of foam are optimized for linear performance, in other words, their performance in a perpendicular impact, they are much too stiff in shear, as occurs in glancing impacts. It has been known for many years that absorbing the energy in linear impacts is important for head protection, and more recently, it has become clear that cushioning impacts that cause rotation of the head is also important to protecting against both severe brain injuries, as well as concussion. Therefore, our goal was to develop a multi-impact material that performs well in both linear and shear impacts over a wide range of impact severities.

This is an early prototype of the material that we developed. They are based on 6D Helmet's omnidirectional suspension technology modified for multi-impact usage. The material comprises top and bottom layers of foam separated by a layer of foam columns glued to the top and bottom layers. As you might expect, since the layer of columns has quite a bit of empty space between the columns, this layer is softer in compression than the top and bottom layers. This provides good impact protection in lower speed, or minor, linear impacts. The layer of columns also allows the top layer to slide laterally relative to the bottom layer in order to mitigate shear impacts. The key breakthrough in our research was identifying a method for making the material softer in shear without changing the linear performance, which allows optimization of the material for both linear and shear performance.

Now that we have won the Head Health Challenge III Grand Prize, our next step is to incorporate this material into a football

helmet and optimize it for both linear and shear impacts in severe and also relatively minor impacts. The research which has brought us to the point where we are now would not have been possible without the Head Health Challenge competition.

The announcement of the competition solicited 125 ideas for improved materials. From that 125, the judging panel selected the most promising five finalists to receive first-round funding to develop their ideas, and of those five, we were selected the Grand Prize winner. This approach in my opinion proved to be a cost-effective way of soliciting a wide variety of ideas from bright people around the country to find potential solutions to a very difficult problem. Without the science prize competition format, the judging panel would not have seen these 125 ideas and would not have benefited from seeing how the five selected ideas could be developed.

In addition, there would not have been the added benefit of competition. It's difficult to quantify, but for me, the competition aspect was a great motivator. We spent hours poring over our simulation models, brainstorming ideas about how to achieve the best results, and wondering what our competition was up to.

In my view, some problems, such as the one we're talking about today, have proved to be difficult for the private sector to solve alone. Funding is very difficult to come by for ideas that have not yet reached a particular level of development, but ideas cannot reach that level of development without funding. For these problems, one of the ways that the federal government can spur innovation is through the use of science prize competitions. In partnership with key stakeholders from the private sector who can provide much-needed financial and technical resources, I believe these competitions can result in revolutionary breakthroughs.

The concussion problem is most visible at the NFL and college levels, but the benefits of improved helmets can go well beyond that. Over one million kids play high school tackle football in the United States, as well as over one million younger children. Protecting them needs to be a high priority.

The materials that we are developing also holds promise for other types of helmets. 6D has already incorporated the key breakthrough that I mentioned earlier into its latest cycling helmet that recently arrived on the market. Potentially, this material could also be used in other multi-impact helmets such as hockey or lacrosse helmets, in other protective equipment such as shoulder pads, in flooring or turf sub-surfaces, or in protective crash barriers on roadways.

In view of my experience with the Head Health Challenge and the important strides that have been made towards improved head impact protection, I would urge you to continue to support science prize competitions. Thank you for your time.

[The prepared statement of Mr. Kebschull follows:]

2017-12-10

Scott Kebschull Bio:

Scott Kebschull is Vice President and Technical Director of Dynamic Research, Inc. of Torrance California. Scott has been with DRI for over 30 years, and during that time has been primarily involved in crashworthiness and occupant protection for passenger cars, motorcycles, and off-road vehicles. Scott was one of the main authors of the ISO 13232 Standard for evaluating protective devices on motorcycles and serves on various committees that develop standards for off-road vehicles. He is an expert in multi-body and finite element computer simulation and was responsible for the finite element simulation work that resulted in the team's winning of the Head Health Challenge III Grand Prize. Scott has a Bachelor of Science Degree in Mechanical Engineering from Valparaiso University and a Master of Science Degree in Mechanical Engineering from the University of Southern California.

Written Testimony of Scott A. Kebschull to the Committee on Science, Space, and Technology, Subcommittee on Research and Technology of the U.S. House of Representatives, "Preventing Head Trauma: The NIST-NFL Head Health Challenge
2017-12-13

BACKGROUND

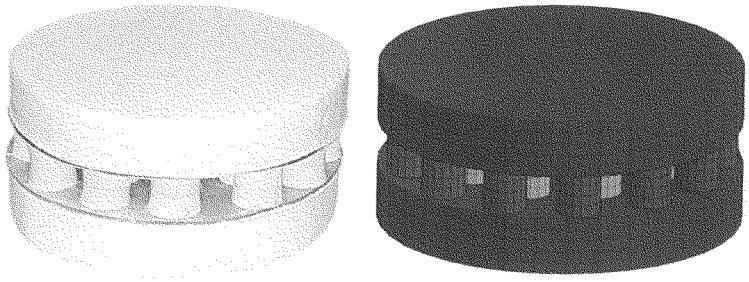
My company, DRI, partnered with 6D Helmets for the Head Health Challenge III prize competition to develop a material, suitable for use in football helmets or other protective equipment, that can better protect against traumatic brain injury. DRI is primarily involved in automotive research and testing as well as helmet research and testing. 6D Helmets designs and manufactures helmets for bicycle and motorcycle riders that uses their patented Omni-Directional Suspension technology. 6D's role in this project was to provide the IP and to fabricate the material samples for testing, and DRI's role was to manage the project, develop the Finite Element (FE) simulation models, and optimize the geometry and material characteristics.

Football helmets with foam liners have been around since the 1950s. With the latest helmets available on the market, fatal head injuries are rare, but concussions still occur frequently.

Traditional helmet liners are made out of monolithic blocks of foam. When these blocks of foam are optimized for linear performance, in other words, their performance in a perpendicular impact, they are much too stiff in shear, as occurs in glancing or angled impacts. It has been known for many years that absorbing the energy in linear impacts is important for head protection, and more recently it has become clear that cushioning impacts that cause rotation of the head is also important to protecting against both severe brain injuries as well as concussions. Therefore, our goal was to develop a ***multi-impact*** material that performs well in both linear and shear impacts and in both severe and relatively minor impacts.

APPROACH

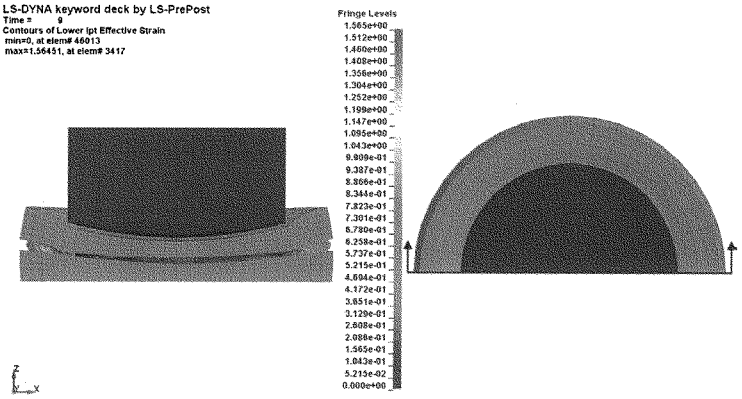
Finite Element models of the prototype material were developed as shown below. Hundreds of computer simulations were run in order to optimize parameters such as the height of the columns; the width of the columns; the spacing of the columns; and the material properties of the top foam, bottom foam, and columns.



Prototype Material (Left) and Finite Element Model (Right)

The simulations allow the evaluation of the stresses and strains at each point in time as shown in the example linear impact simulation below. The colors toward the red end of the spectrum indicate relatively higher levels of strain (deformation),

and the colors toward the blue end of the spectrum indicate relatively lower levels of strain.



Cutaway View of FE Linear Impact Simulation Model Showing Strain Levels

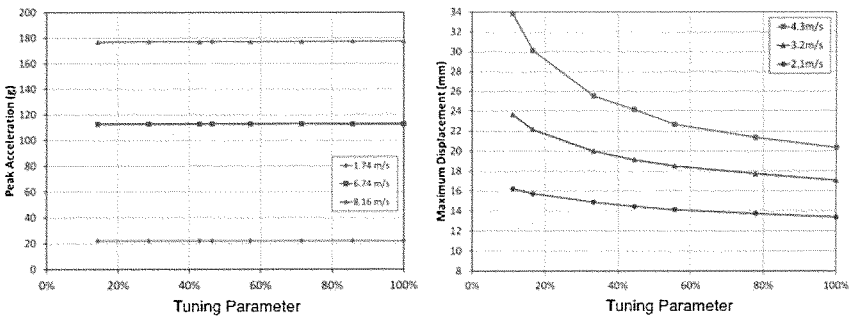
Simulations were also run in order to evaluate other shapes for the columns such as cones, but ultimately the cylindrical shape was selected as the best design.

RESULTS

The material design that was ultimately selected is based on 6D Helmets' Omni-Directional Suspension (ODS) technology, modified for multi-impact usage. It comprises top and bottom layers of foam separated by a layer of foam columns glued to the top and bottom layers. As you might expect, since the layer of columns has quite a bit of empty space between the columns, this layer is softer in compression than the top and bottom layers. This provides good protection in lower speed, or minor, linear impacts. The layer of columns also allows the top layer to slide laterally and rotate relative to the bottom layer in order to mitigate shear impacts.

The key breakthrough in our research was identifying a method for making the material softer in shear without changing the linear performance, which allows

optimization of the material for ***both*** linear and shear performance. The figures below show the effect of a key tuning parameter on the linear and shear performance. In these figures, as the value of the tuning parameter is reduced, the material's linear performance does not change, but in shear, the material becomes softer (allows greater shear displacement).



a. Linear Impact *b. Shear Impact*

Effect of Column Attachment in Linear and Shear Impact Simulations

NEXT STEPS

Now that we have won the Head Health Challenge III Grand Prize, our next step is to incorporate this material into a football helmet and optimize it for both linear and shear impacts in severe and also relatively minor impacts. This will involve using an FE model of an existing commercially available football helmet, including the shell, liner, and facemask. This baseline helmet would be tested in laboratory drop tests in order to validate the results of the simulation model. Then, a liner for the helmet based on the column ODS design would be modeled to replace the baseline liner, and that model would be optimized for linear impacts and shear impacts (oblique impacts) at a range of impact speeds representing sub-concussive level impacts up to very severe impacts.

LESSONS LEARNED

This research which has brought us to the point where we are now would not have been possible without the Head Health Challenge competition. The announcement

of the competition solicited 125 ideas for improved materials. From that 125, the judging panel selected the most promising five finalists to receive first round funding to develop their ideas, and of those five, one was selected the Grand Prize winner.

This approach proved to be a cost-effective way of soliciting a wide variety of ideas from bright people around the country to find potential solutions to a very difficult problem. Without the science prize competition format, the judging panel would not have seen these 125 ideas and would not have benefitted from seeing how the five selected ideas could be developed.

In addition, there would not have been the added benefit of competition. It's difficult to quantify, but to me, the competition aspect was a great motivator. We spent hours pouring over our simulation models, brainstorming ideas about how to achieve the best results, and wondering what our competitors were up to.

In my view, some problems, such as the one we're talking about today, have proved to be difficult for the private sector to solve alone. Funding is very difficult to come by for ideas that have not yet reached a particular level of development, but ideas cannot reach that level of development without funding. For these problems, one of the ways that the federal government can spur innovation is through the use of science prize competitions. In partnership with key stakeholders from the private sector who can provide much needed financial and technical resources, I believe these competitions can result in revolutionary breakthroughs.

The concussion problem is most visible at the NFL and college football levels, but the benefits of improved helmets can go well beyond that. Over one million kids play high school tackle football in the U.S. as well as over one million younger children. Protecting them needs to be a high priority.

The material we are developing also holds promise for other types of helmets. In fact, 6D has already incorporated what we learned in our Head Health Challenge research into their new cycling helmet that has recently arrived for sale in the marketplace.

Potentially this material could also be used in other multi-impact helmets such as hockey or lacrosse helmets, in other protective equipment such as shoulder pads,

in flooring or turf subsurfaces, or in protective crash barriers on roadways and racetracks.

In view of my experience with the Head Health Challenge, and the important strides that have been made toward improved head impact protection, I would urge Congress to continue to support science prize competitions.

Chairwoman COMSTOCK. Thank you very much. And now, we will hear from Dr. Dehgan.

TESTIMONY OF DR. ALEX O. DEHGAN,
CHIEF EXECUTIVE OFFICER AND FOUNDER,
CONSERVATION X LABS

Dr. DEHGAN. Good morning. Chairman Smith, Ranking Member Johnson, Chairwoman Comstock, Ranking Member Lipinski, and other esteemed Members of the Subcommittee, thank you very much for the opportunity to present today.

We face many challenges as a country. Many of those increasingly fail to respect political boundaries, state sovereignty, even military force.

Mr. LIPINSKI. Excuse me, Dr. Dehgan, is the microphone on or you need to move it closer to you.

Dr. DEHGAN. Oh, I'm so sorry. There are challenges that come from scientific competition with new powers that seek to claim our place as America's greatest—as the world's greatest economy and scientific engine.

We've seen that our solutions tend to be linear but the problems are exponential, so we need to incentivize the revolutionary over the evolutionary and broaden the available solutions in our scientific and technical arsenal.

Much as we've created many of these problems, we possess the abilities to address them by harnessing American ingenuity, entrepreneurship, and leadership. Many of these grand challenges are actually grand opportunities, and we can use the power of open innovation to transform the very realm of what is possible, to democratize our ability to solve the challenges that face our nation, and to accelerate and fully harness our nation's ingenuity.

You've heard about my fellow witnesses, about the power of open innovation for the Head Health Challenge. I want to make the case for their larger use. The basic value proposition is this: Instead of looking for the needle in haystack, you're incentivizing the needle to find you, right? Open innovation through prizes, challenges, advanced market commitments solve a fundamental problem that we face in government, that talent is everywhere but opportunity is not. They allow government to be in the business of creating greater opportunity to harness American talent to solve our most pressing problems, to unlock creativity, to break down barriers between scientific fields that are frequently stovepiped.

I want to go through some of the benefits of open innovation. Next slide, please.

[Slide.]

First, and this is very relevant to Congress, they are efficient and careful uses of American taxpayer dollars. They are pay-for-success mechanisms rather than pray-for-success mechanisms. They serve as forms of procurement reform that allow anyone to be able to solve the problem and even can eliminate sources of bias. They leverage additional funds by the innovators. They have low monitoring costs of fund disbursements. They have simple application processes. They were procurement performed for USAID in terms of who could come, and because of that, 50 percent of the applications actually came out of the developing world, came from sectors

that never approached our agency before, and they could also jumpstart very importantly the flow of private capital. They help create new solutions and support out-of-the-box thinking. Because they're focused on the problem and not the solution, they don't constrain the potential innovation space but can draw from new sectors. They can bring in new solvers by mobilizing new talent to what seem to be intractable problems.

The history of science is filled with instances of outsiders proposing novel and ultimately revolutionary solutions to problems that insiders had failed to solve. They attract a diverse group of experts, of practitioners, of laypeople regardless of formal credentials to try to take them on. And we saw that—again, that many of the applicants to the Grand Challenges for Development of USAID were first-time applicants to the agency, and that was important for us.

I want to give one quick example which was Saving Lives at Birth, and it was our very first grand challenge. And it was fundamentally about two problems. How do we ensure that we can provide access to world-class health care to women and children from the onset of labor to 48 hours after delivery, and how do we do so whether—where they give birth, whether in a hospital or a hut, to make that distinction of where they give birth irrelevant to their ultimate success in what we're trying to do?

The reason is we can't afford to build hospitals in every village around the world. We can't afford to train doctors. We can't afford to actually provide the equipment that they needed. So how in the absence of that could we achieve our mission on global health as an agency? And what we found was an outpouring of ideas and innovations that we never even saw before, including one that came from an Argentinian car mechanic that was the first new tool for obstructed labor in 40 years. We never could've seen that. Others came from undergrads, biomedical engineers at Duke and Rice University that are now scaling up. All these tools are now scaling up worldwide.

Finally, prizes and challenges I think can help create new industries. The history of prizes and challenges are filled with that. Napoleon's food preservation prize helped—led to canning, the billiard prize to replace ivory led to plastics, the Orteig Prize helped create the commercial airline industry, the Ansari X prize helped with the private spacecraft industry, and the DARPA Grand Challenge led to self-driving cars. These are great opportunities for our country. Prizes and challenges, they don't work for every case and every situation, but they're a tool within our arsenal to be able to use to advance American innovation. Thank you.

[The prepared statement of Dr. Dehgan follows:]

TESTIMONY OF DR. ALEX DEHGAN, CEO, CONSERVATION X LABS,

BEFORE THE HOUSE SCIENCE, SPACE AND TECHNOLOGY COMMITTEE, SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

WEDNESDAY, DECEMBER 13th, 2017

2318 RAYBURN HOUSE OFFICE BUILDING, WASHINGTON DC

ACCELERATING INNOVATION & HARNESSING AMERICAN TALENT THROUGH PRIZES, CHALLENGES, AND OPEN INNOVATION

THE PROBLEMS ARE BIG, BUT THE OPPORTUNITIES ARE BIGGER

Good Morning. I am Dr. Alex Dehgan, CEO of Conservation X Labs, a conservation innovation company that focuses on finding solutions to the underlying drivers of extinction through exponential technologies, open innovation, and entrepreneurship. I am the former Chief Scientist of the US Agency for International Development.

I want to thank Subcommittee Chairwoman Barbara Comstock, Ranking Member Daniel Lipinski of the Subcommittee on Research and Technology and Ranking Member Eddie Bernice Johnson for the honor to speak about the power of open innovation, particularly prizes and challenges, as a powerful tool of innovation.

We face many challenges as a country. Many of those challenges are ones that increasingly fail to respect political boundaries, state sovereignty, and military force. They are challenges that come from the growing billions emerging into the middle class around the world, and the demands and competition that they will place on our resources, and their growing demand for dairy, protein, air conditioning, and refrigeration. They are challenges that come from new nations that seek to claim our place as the world's greatest economy and leader of the free world. Even the challenges that affect other places, other countries, other

peoples, are challenges increasingly capable of undermining American economic growth, and destabilizing our national security. Increasingly, we have seen that our solutions are linear, but our problems are exponential. We must incentive the revolutionary over the evolutionary in the available solutions in our scientific & technological arsenal.

However, much as we have created many of these problems, we also possess the abilities to address them by harnessing American ingenuity, entrepreneurship, and leadership. Many of these grand challenges are increasingly grand opportunities. We can use the power of open innovation to transform the very realm of what is possible, to democratize our ability to solve our biggest challenges, and to accelerate our nation's ingenuity and inventiveness.

Given the speed and scale of the problems that face us, many of which have their genesis as questions of science & technology, and similarly, their solutions, we can accelerate the speed of innovation through prizes and challenges as one of a suite of tools for innovation in science & technology, and research.

THE VALUE PROPOSITION: PRIZES ACCELERATE INNOVATION, ALLOW US TO MORE FULLY BENEFIT FROM THE DEMOCRATIZATION OF SCIENCE & TECHNOLOGY, AND HARNESS PLANETARY GENIUS BY OPENING THE DOOR TO NEW SOLVERS AND SOLUTIONS.

Open Innovation through prizes, challenges, and advanced market commitments solves a fundamental problem that we face as a government. While talent may be everywhere, opportunity is not. Open innovation allows the government to be in the business of creating greater opportunity to harness American (and when appropriate, global) talent to solve our most pressing problems, unlock new solvers and new solutions, breakdown barriers between scientific fields that are frequently stove-piped.

Unlike traditional grant or investment programs, they eliminate hidden biases by focusing on the problems rather than the solutions and encourage competition. They help translate and source new ideas from adjacent technical spaces, identify excellence, and allow funders to uncover the landscape of potential solutions and understand emerging trends. This has the net effect, when executed properly, of allowing us to accelerate innovation, break

down barriers among fields, and allow us to more fully harness the democratization of science and technology.

While the concept of prizes and challenges is not new, there is a renewed enthusiasm for their use. Before 2009, NASA, DOE, and DOD had limited authority to offer incentive prizes, and they conducted only a handful of competitions. Between 2009 and 2015, the federal government conducted more than 440 prize competitions and challenges. This increase in prizes and challenges demonstrates the power these tools have to transform how we find solutions.

WHAT IS A PRIZE, A CHALLENGE, OR AN ADVANCED MARKET COMMITMENT?

Prizes, Challenges, and Advanced Market Commitments are a relatively straightforward approach to finding solutions, yet require highly strategic implementation to efficiently and successfully identify impactful and innovative solutions.

Prizes award a single winner, using the first to achieve a clear objective or goal. They are intended to move the needle in terms of potential solutions, demonstrate a breakthrough, literally showing that the impossible is now possible. Monetary prizes can help spur private-sector action by offering a lump sum to winners of contests, but prizes may utilize other types of incentives and structures beyond monetary prizes, including recognition, advanced market commitments, media attention, and credibility. These lump sums typically represent a return on investment for the winners, and use the psychology of gamification to incentivize previously untapped innovators and encourage them to engage with difficult problems.

Challenges are similar to prizes in the way they tap into the wisdom and experience of "unusual suspects." Unlike prizes, however, they reward a few winners, rather than a single winner. They seek to spur collaboration, especially cross-sectoral collaboration, and participation to solve large, seemingly intractable public problems and to build communities of practice, essential for building new ecosystems of solutions, rather than a single point solution. By bringing together insight and experience from a variety of actors with different backgrounds,

challenges can inspire out-of-the-box thinking and innovative approaches to problem solving. Finally, they help map the larger landscape of potential innovations.

Advanced Market Commitments. Advanced Market Commitments (AMCs) are a type of prize. An AMC is a legally-binding agreement for an amount of funds to subsidize the purchase, at a given price, of an as yet unavailable product whose creation would create a substantial advance against a specific challenge. The establishment of AMCs should encourage the development of future generations of such innovations, and work to resolve a market failure, by creating incentives for private industry and capital to generate such solutions. They essentially serve to derisk research and development by guaranteeing a market.

Prizes, Challenges, and AMCs can be incredibly powerful tools to focus attention on a problem, without being constrained by existing communities of practice. A prize can be useful to focus on a specific breakthrough, while a challenge could result in a community of possible solutions. With well-developed problem statements and identified characteristics of a solution, a challenge or prize model may be employed for rapidly developing deployable solutions. If significant research and development is needed to bring identified solutions to market, a challenge can lead to an identified community of solutions that can then be rapidly developed for scale.

BENEFITS OF OPEN INNOVATION

Prizes, Challenges, AMCs, and other forms of open innovation offer a number of advantages when well executed.

1. EFFICIENT & CAREFUL USES OF AMERICAN TAXPAYER DOLLARS

Prizes and challenges are efficient and cost-effective uses of American taxpayer dollars. First, they are pay for performance mechanisms. You only pay for success - Prizes and challenges are only paid when a specific objective is met or a specific problem in solved.

Moreover, rather than searching for the right solution to a problem, through a contract or grant, they incentivize the solution to find you.

Second, they are forms of procurement reform. At USAID, we were heavily straddled with systems that prevented us from working with all but a small number of implementers. Moreover, the cost of even being able to apply for USAID funding is in the thousands of dollars. By creating an open, transparent, and simple process that is focused on outcomes, not process & bureaucracy, they open the door for new entrants and even build momentum for new entries. They also serve to eliminate hidden biases of traditional grant programs by focusing on the problems rather than the solutions. While experts may be able to help identify the problems we want solved, the complexity of science and technology prevent any single person or institution from owning most of the solutions.

Moreover, prizes and challenges can be an extraordinarily effective use of resources due to the leveraging of additional funds by the innovators themselves, low monitoring costs of fund disbursement, a relatively simple application process (compared to grant funding), quicker feedback cycles, and streamlined review based on simple solutions-based criteria.

Third, prizes and challenges also provide additional layers of motivation beyond money, such as prestige, recognition and credibility, and intellectual curiosity. In an era when more and more people want to see solutions to societal problems that have proved resistant to traditional market or academic solutions, prizes—and their flexibility to address a range of issues— are increasingly valuable for social entrepreneurs who benefit from prize money and the recognition from the global community, and for prize sponsors seeking change.

Fourth, prizes and challenges provide substantial leverage and mitigate risks for American taxpayer dollars. At USAID, because of the size of the Grand Challenges, we executed all the Grand Challenges for Development with other partners – this included other bilateral and multilateral development agencies, foundations like Gates and Omidyar, and private sector companies. This had multiple benefits to the American taxpayer. We were able to mitigate risk among multiple organizations, and leveraged considerable prize capital among multiple parties,

as well as were able to incentivize a greater number of participants to compete for the prize through greater amplification through each of the partners.

Saving Lives at Birth, our first Grand Challenge for Development, is an insightful example. It sought to address two problems. First, if we could provide medical care to women and their children from the onset of labor to 48 hours after delivery, no matter what was the setting in which they gave birth – in a hospital or a hut – we could dramatically improve the chances of survival for both the mother and the child. Second, we recognized that there weren't sufficient resources, even among all the development agencies in the world, to build world-class hospitals, equipment, and well trained physicians and nurses in every village that needed them to save the lives of women and children. We needed to be innovative. Specifically, we needed to create innovations for maternal and child-care that ensure their survival and health irrespective of where a woman gave birth. Saving lives at Birth, which became a partnership of Gates, Norway, Korea, the United Kingdom, Grand Challenges Canada, ended up leveraging for US taxpayers $100 Million+ in external funding, based on an investment of $20 Million by the US. Overall, the Grand Challenges program at USAID has leveraged over $400 million in external funding.

Finally, prizes, challenges, and AMCs can also jumpstart the flow of private capital. They serve as vetting mechanisms for the private sector. And through AMCs, we may harness the private sector to create new market incentives for private investment. The Department of Energy Better Buildings Advanced Market Commitment partnered with private sector commercial firms, like Whole Foods, to make commitments of increasing cooling efficiency on all its buildings, creating a market incentives for manufacturers to improve existing cooling technology. Since 2013, 300 partners have replaced or upgraded a total of 77,000 units, saving over $166 million in energy costs and racking up $66 million in savings in 2016 alone.

2. CREATING NEW SOLUTIONS & ACCELERATING INNOVATION

Prizes, challenges, and AMCs also help create new breakthrough solutions and accelerate innovation. They do this by focusing on the problem, not the solution, and as such,

they do not constrain the potential innovation space. When well crafted, they set aspirational goals for discovery and invention, which incentivizes the entry of new disciplines, and the application of breakthroughs from adjacent fields to being applied to new problems in new ways. This helps translate and source new ideas from adjacent technical spaces, and allows the funder to uncover the landscape of potential solutions, understand emerging trends, and create communities of interests. A recent Harvard Business School report, The Value of Openness in Scientific Problem Solving, found that "the further the problem was from the solver's expertise, the more likely they were to solve it."[1]

The US Government has used prizes and challenges to accelerate innovation on important human health and security challenges where traditional approaches were insufficient. These include, but are in no way limited to:

- **Food Safety:** The Food and Drug Administration launched the Food Safety prize competition in 2014 to encourage innovators to think of ideas that would quickly detect disease-causing organisms in food. The winning team from Purdue University, led by Professor Michael Ladisch, developed a technology that concentrates Salmonella to detectable levels using automated microfiltration, making it possible to process samples in hours instead of days.
- **Desalinization**: The U.S. Agency for International Development (USAID) and the Bureau of Reclamation challenged innovators around the world to create cost-effective, energy efficient, sustainable desalination technologies to provide water for people and crops. The winning Massachusetts Institute of Technology (MIT) team designed a solar-powered system that removes salt from water with electricity and uses ultraviolet rays to disinfect the water, showing the potential for photovoltaic-powered electrodialysis to be a scalable, sustainable, and affordable desalination technology for rural areas of developing countries.

[1] Karim R. Lakhani, et al. 2007. "The Value of Openness in Scientific Problem Solving," Harvard Business School working paper.

- **Disease Outbreaks**. USAID used prizes and challenges to accelerate innovation for child and material care, education, energy & agriculture, water, but most recently, has been using prizes and challenges as ways of addressing the Ebola and Zika outbreaks.

3. NEW SOLVERS – MOBILIZING NEW TALENT

The ability of prizes to mobilize new talent to focus on difficult problems is an important driver of innovation. The history of science is filled with instances of outsiders proposing novel and ultimately, revolutionary solutions to problems that had vexed insiders. At USAID, the Agency has increasingly seen prize and challenge applicants coming from sectors that have never previously approached the Agency. Many awards were from first-time applicants and a significant number of applications, and a growing share of the winners, came from the developing world. It makes sense that those closest to the problem may have some good ideas of how to address it. Prizes and challenges provide that opportunity.

Prizes also attract diverse groups of experts, practitioners, and laypeople—regardless of formal credentials—to attempt to solve difficult problems. The citizen-inventor working out of a garage is a cherished part of prize lore. Technology may allow more garage innovators to succeed. The democratization of science & technology through exponential gains in the power of technology and exponential decreases in the cost of computing power and storage, greater connectivity through the internet and cell phones to an ever increasing and unprecedented trove of human knowledge, the merger of biology and technology to advance molecular sciences & microbiology, and the many ways the information technology enables cheap and easy collaboration are working together to dramatically expand the pool of potential solvers and lower the cost of attempting or recognizing solutions.[2]

Saving Lives at Birth, USAID's Grand Challenge, for instance was notable for one of its winners: an Argentinian car mechanic who created one of the first new innovations for

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[2] McKinsey & Company. 20009. *And the Winner Is: Capturing the Promise of Philanthropy Prizes.* Read Developing and Delivering Effective Prizes.

obstructed labor in 40 years inspired by a Youtube video. Innovation can come from many sectors, and we can use prizes and challenges to uncork it.

Incentives prizes also provide more entrepreneurial opportunities for under represented sectors because they level the playing field.[3] In a study of more than 166 science challenges involving over 12,000 scientists, open innovation scholars Karim Lakhnai and Lars Bo Jeppesen found that "female solvers—known to be in the 'outer circle' of the scientific establishment—performed significantly better than men in developing successful solutions." By "removing barriers to entry to non-obvious individuals," prizes increase access to innovation.[4]

4. CREATING NEW INDUSTRIES

Prizes, challenges and AMCs have the power to create entire new industries, markets, businesses, and leaders while extending the frontiers of possibility. This may be because they make the impossible possible, and capture the public imagination. That breakthrough effect serves to galvanize others to enter into the space, including again, investors and finance. The history of prizes and challenges is filled with such examples:

The Longitude Prize created by an act of Parliament in the UK in 1714 was used to establish a simple and practical method for precisely determining a ship's longitude, which greatly facilitated transatlantic shipping. Napoleon issued a prize in 1794 for a new method to preserve food and avoid loss of capacity from food poisoning, particularly "when an invaded country was not able or inclined to sell or provide food." That prize led to canning, which was won by a French confectioner Nicholas Appert, who lacked any formal training in science. He went on to create a canning factory that revolutionized food safety. In 1863, the first conservation prize, intended to replace ivory in billiard balls, provided $10,000 for the inventor of a suitable substitute as ivory became increasingly scarce. It resulted in a celluloid that helped spur the modern plastics industry.

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[3] pers. comm. Jenn Gustetic, NASA

[4] Lars Bo Jeppesen, and Karim Lakhnai, "Marginality and Problem Solving Effectiveness in Broadcast Search," Organization Science 21 (2010): 1016. doi 10.1287/orsc.1090.0491.

Two more recent prizes stand out. The Orteig Prize in 1919 promised $25,000 to the first Allied aviator who could cross the Atlantic from Paris to New York or New York to Paris in a single flight. Charles Lindberg, who had been a mail messenger flying from St. Louis to Chicago, took out a $15,000 bank loan, and won that prize in 1927 in the *Spirit of St. Louis*, a feat which was thought impossible. Within 18 months of that flight, the modern airplane industry was born. Passenger traffic increased 30 times, the number of aircraft increased 4 times, pilot applications increased four times, and aviation stocks stored.

Similarly, the Ansari X Prize, which was a $10-million prize for the first team to privately build a spacecraft that could carry 3 adults to 100 km twice in a week, helped incentivize the private space craft industry. Twenty-six teams, from 7 nations, spent over 100 million dollars competing for the prize, which lead to over a billion dollars of investment in the sector. The Ansari X-prize helped create a new wave of commercial space exploration and contributed to a fundamental shift in NASA's approach to travel to low earth orbit. Even the non-winners found it helpful: 40% of non-winning participants said the process of applying was helpful in clarifying their ideas and connecting them with new partners. Half were still developing their solutions even though they did not receive funding from the prize competition. The winning ship, SpaceShipOne, sits in the Air and Space Museum on the Mall next to the *Spirit of St. Louis.*

A final example of how prizes and challenges incentivize new industries was 2004 DARPA Grand Challenge that helped lead to the self-driving car revolution. Fourteen years ago, the idea of a self-driving car seemed within the realm of science fiction, when DARPA first launched its Grand Challenge.

The immediate goal of the DARPA Grand Challenge was to autonomously navigate a 142-mile course across a Nevada desert. The first team to pass a series of qualification tests and then complete the course in less than 10 hours would win a million-dollar cash prize. The longer-term aim was to accelerate development of the technological foundations for autonomous vehicles that could ultimately substitute for men and women in hazardous military operations, such as supply convoys.

Like other challenges, it was a way to incentivize new solvers and solutions, and build new communities of practice and collaborations across diverse fields. No one won the first round, however, with the top-scoring vehicle traveling only 7.5 miles. The competition however offered a chance to view the future and see that autonomous driving was possible. A second Grand Challenge took place 18 months later in 2005, and 5 vehicles successfully completed the course. DARPA conducted a third competition, the Urban Challenge, in 2007 that featured driverless vehicles navigating a complex course in a staged city environment in Victorville, Calif., negotiating other moving traffic and obstacles while obeying traffic regulations. These would have the effect of encouraging the development of a multibillion dollar autonomous vehicle industry that looks to change the American landscape.

5. ITS NOT JUST ABOUT THE WINNERS

Finally, through my work at Conservation X Labs and at USAID, I have learned that prizes and challenges are not enough, but can be complemented by other mechanisms. There is a great value to harnessing both competitive and collaborative mechanisms to spur innovation. For this reason, in addition to running prizes and challenges, we have investing into mass collaboration – through the creation of a Digital Makerspace, a collaborative innovation platform - to encourage the development of ideas that were successful. Many of the innovations that don't win may still have nuggets of innovation, that when combined with other ideas or further iterated on, can provide powerful solutions.

Mass Collaboration, another form of open innovation, has previously solved significant problems. The Open Source Drug Discovery (OSDD) created a large community comprised of more than 5,700 registered users of the portal from 130 countries, who helped create new license-free drugs for malaria and TB that were not being created by traditional pharmaceutical industry.

RULES FOR EFFECTIVE PRIZES AND CHALLENGES

While powerful tools, prizes and challenges need to be executed effectively to work well. This requires a focus on problems, not solutions, which frequently sounds easy, but is difficult to achieve. Prizes, challenges, and AMCs must ensure that they are solving the right problem, and a problem that is sufficiently audacious but achievable. They must address a large enough and important enough problem to excite, inspire, and attract broad communities of solvers, from disparate fields, to the problem. They must target by definition-- a market failure. They also must clearly define the criteria for winning.

Second, there must be a sufficient purse. Prizes shift the risk to the participants as a pay for success mechanism. As such, there has to be a sufficient understanding of the participant cost structure to incentivize their participation. This is especially true of prizes and AMCs where the purse must also be large enough to attract broad public attention and create demand for the solutions.

Third, execution is critical. My experience at USAID has taught me integrating procurement and legal teams with the design teams is necessary to create a great prize. It must be rewarding and simple for both teams to participate and for Agencies to operate. There are increasingly sophisticated ways to run prizes, using staged capital to incentivize greater success, and create a pathway to scale. It is not enough just to design a prize, but we must design for what happens afterwards. Scale must be built into the process from the beginning.

However, most things are not a prize or a challenge. Prizes, challenges, and AMCs are a tool in a research and technology portfolio. They should only be used when there is a clear and measurable outcome defined in advance. They are best when taking on problems where the objective is clear, but the way to achieve it is not. As McKinsey noted in its report, *And the Winner is,* "By attracting diverse talent and a range of potential solutions, prizes draw out many possible solutions, many of them unexpected, and steer the effort in directions that established experts might not go but where the solution may nonetheless lie."

CONCLUSION

Prizes, challenges, and AMCs are powerful tools in our science & technology toolbox for advancing American innovation and solving wicked problems. While they are not right for every approach, or even most of them, they can transform the realm of what is possible, allow for greater interdisciplinary solutions, attract new solvers and solutions, and catalyze new industries.

Such open innovation tools have the very qualities that define the best of American values and spirit – they are entrepreneurial, rely on self-selection, are by definition open and transparent, and reward merit, ingenuity and hard work. In some ways, they reflect the values of the American story, where everyone has a chance, and the pathways to success are open to anyone.

DR. ALEX DEHGAN – PROFESSIONAL BIOGRAPHY

Alex Dehgan is the CEO & co-founder of a new startup, Conservation X Labs, focused on harnessing exponential technologies, open innovation, and entrepreneurship for addressing global challenges, including launching the first Grand Challenge for Conservation on Aquaculture, creating the first digital makerspace, and developing a new handheld microfluidics based DNA field scanner. He is also The Chanler Innovator in Residence at Duke University and previously served as the Inaugural Rubenstein Fellow, where he researches and lectures on technology innovation for the SDGs.

Dr. Alex Dehgan recently served as the Chief Scientist at the U.S. Agency for International Development, with rank of Assistant Administrator, founded and headed the Office of Science and Technology, and created the vision for and helped launch the Global Development Lab, the Agency's DARPA for Development. As the Agency's first chief scientist in two decades, Dr. Dehgan implemented the President's promise to restore science and technology to its rightful place within USAID. Alex was the architect of a number of new Agency institutions, including the Grand Challenges for Development program, Agency partnerships with universities (HESN) and federal science agencies (PEER), the independent office of science and technology (OST), the position of the Agency geographer and the GeoCenter, and data for development programs, and the Global Development Lab. In less than four years, Alex built OST from scratch to an 80-person office, a $100 M dollar research program, and leveraged or raised $500 million dollars from other donors and partners. Alex was also part of the founding team for the creation of the Policy, Planning, and Learning Bureau (PPL), rebuilt technical capabilities in the Agency by putting scientists, physicians, and engineers directly into USAID missions and technical bureaus, and led efforts for the Agency's research policy and first ever scientific integrity policy.

Prior to coming to USAID, Alex worked in multiple positions at the Department of State, including the Policy Planning Staff, the Office of the Secretary, the Office of the Science Adviser (STAS), and the Bureau of Near Eastern Affairs, and the Coalition Provisional Authority in Iraq. At State, Alex developed political and science diplomacy strategies towards addressing our most challenging foreign policy issues in Iran, Iraq, and the greater Islamic world, including helping initiating the Obama Administration's diplomatic efforts with Iran through science diplomacy working with Amb. Dennis Ross, and serving as a liaison to the late Amb. Richard Holbrooke.

Alex Dehgan was also the founding Afghanistan Country Director for the Wildlife Conservation Society's Afghanistan Biodiversity Conservation Program. Through his leadership, WCS led efforts to create Afghanistan's first national park, conducted the first comprehensive biological surveys of the country in 30 years, helped develop Afghanistan's biodiversity conservation laws and policies, and curtailed illegal wildlife trade on US and ISAF military bases. Alex is also currently writing a book, *The Snow Leopard Startup*, through Public Affairs, an imprint of Perseus Books Group, on setting up the first national park in Afghanistan.

Dr. Dehgan holds a Ph.D and M.Sc. from The University of Chicago's Committee on Evolutionary Biology, where he focused on extinction and adaptation of 12 lemur species during environmental change in tropical forests in Madagascar. He also holds a J.D. from the University of California, Hastings, and a B.S. from Duke University. He was chosen as an "Icon of Science" by Seed Magazine in 2005, received the World Technology Award for Policy in 2011, and has been recognized through multiple awards from the Departments of State and Defense, and USAID. In 2013, AAAS selected Alex as one of its 40@40 fellows out of 2,600 AAAS Science Policy Fellows as "an individual who has made exemplary dedication to applying science to serve society, was creative, innovative, and collaborative problem solvers in addressing global challenges, and was an uncommon ambassador for the role of science and technology."

Chairwoman COMSTOCK. Thank you. And I now recognize Mr. Springs for his testimony.

TESTIMONY OF MR. SHAWN SPRINGS,
CHIEF EXECUTIVE OFFICER, WINDPACT

Mr. SPRINGS. Good morning, Chairwoman Comstock and Ranking Member Lipinski and distinguished Members of the Subcommittee. Thank you for the opportunity to participate in today's discussion on the Head Health Challenge. My name is Shawn Springs. I'm the Chief Executive Officer of Windpact, a northern-Virginia-based safety technology company I founded in 2011.

Windpact is an innovative startup with a goal to become the most advanced impact protection company in the world. We leverage our patented Crash Cloud technology to improve impact performance in helmets and protective gear.

Learning and accepting the guidance from the medical community, our aim is to be the catalyst of innovation for impact protection technology so manufacturers can build better products for their customers. Windpact partners with top equipment brands to improve products by replacing their existing padding with our Crash Cloud technology. We are working with multiple customers across sports and recreation, including football, baseball, lacrosse, and hockey brands, and are in negotiating partnerships in other sectors, including the military and automotive.

My inspiration for founding Windpact stems from my desire to make playing sports safer for the next generation of athletes. I spent 20 years playing football, including 13 years in the National Football League.

Windpact has participated in a few Head Health Challenge competitions resulting in a first-place victory in the First and Future Competition, which was held during Super Bowl weekend down in Houston, partnering with the NFL and Texas Medical Center, the largest medical center in the world. There were 200 participants, and we were fortunate to come out and win our category for best materials for the game, as well as an award under the HeadHealthTECH Challenge—a group of challenges launched over the last 12 months through collaboration with NFL and Duke University's Clinical and Translational Science Institute. We won our second award.

As a startup company, gaining access to, and trust from, larger brands can be a challenge. As a recipient of multiple awards, we have found that a formal acknowledgement and support of our technology by an institution like NIST or Duke University's Clinical and Translational Science Institute through the HeadHealthTECH program provides welcome validation and legitimacy to our own findings.

I strongly believe that public-private science prize competitions are invaluable to the advancement of player safety. The NFL has done a good job the past few years partnering with corporations and research facilities to encourage the improvement of the technology to protect its players. Having sustained concussions and witnessed concussions among friends and teammates, I developed a sense of urgency and obligation to work towards a solution and af-

fect change. It's important to me to protect the future of players from injury and make both the game I love and other sports safer.

There has been a growing negative attention directed to sports in the past few years with the elevated awareness of concussions and injury, resulting in a reduced participation, especially at the youth level. I feel strongly that is the opposite reaction that we need. Team sports and recreational activities are invaluable in what they provide to our communities and children.

While football has received the bulk of the attention for injuries to its athletes, they are now also receiving compliments for the work they are doing to spur innovators, entrepreneurs, and manufacturers to build the next generation of protective gear. It's imperative for other industries to follow suit by creating their own initiatives to improve safety. Protecting our loved ones with better equipment is Windpact's mission statement, but it is also a common goal for parents, players, coaches, emergency responders, and military personnel as well.

Our experience has been that public-private science prize is an excellent way to spur innovation and speed up much-needed improvements to the market. The right partners and support of the funding program like Head Health Challenge are providing opportunities to young companies beyond what otherwise would be accessible to them. I recommend the continued exploration and investment in these types of competitions across sports and beyond.

Another operation is needed to continue to update and modernize standards. This underscores the need to update standards as go hand-in-hand with private sector innovation. Windpact welcomes the opportunity to participate in future challenges. Science prize competitions spur innovation, and that requires significant capital investment.

Thank you for the opportunity to offer my testimony, and I look forward to answering any questions.

[The prepared statement of Mr. Springs follows:]

windpact

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"*Head Health Challenge*: Preventing Head Trauma from Football Field to Shop Floor to Battlefield."

U.S. House of Representatives

Wednesday, December 13, 2017

Written Testimony

Shawn Springs, Chief Executive Officer, Windpact, Inc.

Chairwoman Comstock, Ranking Member Lipinski and distinguished members of the Subcommittee, thank you for the opportunity to participate in today's discussion on the *Head Health Challenge*.

My name is Shawn Springs. I am the Chief Executive Officer of Windpact, a Northern Virginia based safety technology company I founded in 2011. Windpact is an innovative startup with a goal to become the most advanced impact protection company in the world. We leverage our patented Crash Cloud™ technology to improve impact performance in helmets and protective gear. Learning and accepting guidance from the medical community, our aim is to be the catalyst of innovation for impact protection technology so manufacturers can build better products for their customers.

Windpact partners with top equipment brands to improve products by replacing their existing padding with our Crash Cloud technology. We are working with multiple customers across sports and recreation, including football, baseball, lacrosse and hockey helmet brands, and we are currently negotiating partnerships in other sectors, including the military and automotive.

My inspiration for founding Windpact stems from my desire to make playing sports safer for the next generation of athletes. I spent over 20 years playing football, from the youth level to the professional level, playing 13 years in the National Football League (NFL). Football is a beautiful sport when played properly within the confines of the rules. Even when played correctly, there are some inherent dangers that are unavoidable. Having sustained concussions and witnessed concussions among friends and teammates, I developed a sense of urgency and obligation to work towards a solution and effect change. It is important to me to protect future players from injury and make both the game I love and other sports safer.

There has been growing negative attention directed at sports in the past few years with the elevated awareness of concussions and injury, resulting in a reduced participation in sports,

especially at the youth level. I feel strongly that this is the opposite reaction that is needed. Team sports and recreational activities are invaluable in what they provide to our communities and our children. Studies have found that participation in these activities makes us healthier, and the values of teamwork, hard work and discipline have been shown to make more productive citizens.

In 2013, the NFL, General Electric and Under Armour announced a partnership with the National Institute of Science & Technology (NIST) with the launch of the *Head Health Challenge I, II & III*. This four-year, $60 million collaboration was formed to accelerate the diagnosis and improvement of treatment of traumatic brain injury. The *Head Health Challenge* (HHC) was followed by additional programs supported by the NFL's Play Smart, Play Safe initiative. The annual *1st and Future Startup Competition* held at the Super Bowl, which last year, teamed the NFL with Texas Medical Center and the *HeadHealthTECH (HHTC)* group of challenges, launched over the last 12 months, which teamed the NFL and Football Research, Inc. (FRI) with Duke University's Clinical and Translational Science Institute.

Windpact has participated in a few of the *Head Health Challenge* competitions, resulting in a first-place victory in the *1st and Future Competition*, as well as an award under the *HeadHealthTECH II Challenge*.

As a startup company, gaining access to, and trust from, larger brands can be a challenge. As a recipient of multiple awards, we have found that the formal acknowledgement and support of our technology by an institution like the NIST or Duke University's Clinical and Translational Science Institute, through the *HeadHealthTECH* program, provides welcome validation and legitimacy to our own findings. This has opened doors with funding partners as well as commercial opportunities, which are so critical to gaining traction as an emerging company.

Through our applications to *HHC* and *HHTC* programs, we learned the importance of understanding the specific underlying mission behind each of the programs. For instance, the first *Head Health Challenge* was focused on improving the diagnosis and treatment of patients with traumatic brain injury. Windpact initially applied to the *Head Health Challenge II*, but the program mission didn't perfectly match our business model and technology, and our application was turned down. The *HeadHealthTECH* challenge is specifically aimed at commercializing and deploying technologies that show promise in improving the health of professional football players. The *HeadHealthTECH* challenge has a mission in alignment with Windpact's current state of development, ultimately resulting in their decision to award our company funding.

Additionally, we learned the importance of tailoring an application to fit those program goals. In one instance, Windpact's grant application requested funds that would enable us to achieve significant gains on several development fronts, including physical prototyping of helmets, as well as initial brain modeling and virtual model simulation. Ultimately, our application was too ambitious for the program and Windpact was not selected as a recipient of that grant. We drew on our experience and our subsequent successful application contained a significantly pared back set of objectives and smaller funding request.

Based on our experience with these competitions, I strongly believe that public-private science prize competitions are invaluable to the advancement of player safety. The NFL has done a good

job the past few years partnering with corporations and research facilities to encourage the improvement of technology to protect its players. And while football has received the bulk of the attention for injuries to its athletes, they are now also receiving compliments for the work they are doing to spur on innovators, entrepreneurs and manufacturers to build the next generation of protective gear.

Other industries can follow suit by creating their own initiatives to improve safety. Protecting our loved ones with better equipment is Windpact's stated mission, but it is also a common goal for parents, players, coaches, emergency responders, military personnel, and others. Our experience has been that the public-private science prize is an excellent way to spur innovation and speed much needed improvements to market. With the right partners supporting the funding, a program like the *Head Health Challenge* provides opportunities to young companies beyond what would otherwise be accessible to them. We would recommend continued exploration and investment in these types of competitions across sports and beyond.

As it applies to head health among athletes, studies have highlighted the dangers of concussion in a wide variety of sports, including football, hockey, lacrosse, wrestling, rugby, and girls' soccer. Due to recent studies, women's lacrosse, for example, is facing new standards for protective headgear. The state of Florida is the first to mandate that all girls playing high school lacrosse wear headgear, and it is widely expected that other states will follow suit. Windpact's technology is in the first girls' lacrosse headgear to pass the stringent ASTM standards.

Head protection in the cycling industry offers another significant opportunity for new standards and innovation driven by public-private funding support. Today, most cycling helmets continue to rely on dated rigid foam technology to address an outdated Consumer Product Safety Commission certification standard. Anecdotally, we know that concussions and other mild traumatic brain injuries can occur at impact speeds far below those measured by the certification standard.

Another consideration for leveraging prize money to spur innovation is evaluating the size of the grants. Using *HeadHealthTECH* as an example, from a significant pool of funds ($60 million), the program appears to be on track to award many very modest sized grants, from $20,000 to $190,000. This is helpful to spread funding to multiple recipients, but also limits the gains any one recipient can make with prize funding. I would recommend more flexibility in award size to encourage bolder and more ambitious ideas, as well as those that demonstrate incremental improvements.

Thank you for the opportunity to offer my testimony and I look forward to answering any questions.

Shawn Aaron Springs

Shawn Springs is the CEO and Founder of Windpact, Inc., a Northern Virginia based safety technology company leveraging its patented padding technology to improve impact performance in helmets and protective gear in sports, military and recreation. Shawn, an entrepreneur, visionary and investor, has participated in numerous businesses, from real estate to tech startups. Additionally, Shawn works during the NFL season as a local commentator/ anchor for NBC Sports, discussing all things relating to the Washington Redskins. He also appears on ESPN and NFL Network.

His inspiration for founding Windpact came from a car seat made by Dorel Juvenile. Shawn was using the car seat to transport his children when he was struck with the idea that perhaps the same technology being utilized to protect his kid's heads in an auto accident could be transferred into helmets to protect athletes, soldiers, etc. After 13 years as a football player in the NFL, Shawn sustained or witnessed enough concussions to realize that if he had found a way to protect future players from injury, then it was his obligation to work to develop this technology.

Shawn is a graduate of The Ohio State University and completed a Bachelor of Science in Sociology. At Ohio State, as a member of the football team, he was a two-time Academic All-Big Ten Athlete and was named the Big Ten Defensive Player of the Year in 1996 despite having no interceptions. While attending Ohio State, Shawn served as the President of the Majority of One Program, a program offering support, scholarships and mentoring to minority students.

In 1997, Shawn entered the National Football League and was drafted by the Seattle Seahawks with the third pick overall. He remains the highest cornerback ever drafted in the NFL and spent 7 years in Seattle playing under Mike Holmgren and Dennis Erickson. He was selected to the ProBowl in 1998. While playing for the Seahawks, Shawn continued his education and attended the University Washington, where he was inducted into the Society of National Collegiate Scholars.

He was signed as a free agent in 2004 by legendary coach Joe Gibbs and the Washington Redskins. While playing for the Redskins, he became the only player in NFL history to lead his team statistically with sacks and interceptions in the same year (2005). He finished his career in 2010 by spending a year playing for Bill Belichick and the New England Patriots.

During his time in the NFL, Shawn was the Founder and President of the Springs for Life Foundation, a non-profit which supported at-risk youth. Additionally, he committed himself to charitable organizations seeking a cure for diabetes and continues to participate in numerous events for the Juvenile Diabetes Foundation and the American Diabetes Association. For his continuous dedication to community work, both the Seahawks and Redskins chose him to represent them as an NFL Walter Payton "Man of the Year." In 2009, he was selected as a "Washingtonian of the Year" by Washingtonian Magazine.

Since retiring from the NFL and founding Windpact, Shawn has been active in lobbying the government to improve consumer safety standards in protective gear. He regularly appears on The Hill for meetings with senators and congressman, discussing not only head protection but the importance of health and physical fitness at the school level.

Shawn gave a TEDx Columbus talk in 2015 entitiled "Tackling Helmet Protection Head On"

Shawn's father, Ron Springs, was an All American and team captain at Ohio State University. Ron played 9 NFL seasons with the Dallas Cowboys and Tampa Bay Buccaneers. Born in Williamsburg, VA, Shawn went to high school in Maryland at Springbrook High School in Silver Spring, MD. He currently resides in Northern Virginia, where he spends time coaching local youth football teams, mentoring athletes working to get to the college level and training his own sons who all play football.

His company website is **www.windpact.com**. He can be reached via email at **shawn@windpact.com**

Chairwoman COMSTOCK. Thank you so much. And I really thank the witnesses for their testimony. And in addition to the testimony submitted by our witnesses today, I ask unanimous consent that the written testimony submitted by Mr. Robert Reisinger, Co-founder and Director of Engineering at 6D Helmets and co-winner of the Head Health Challenge be included in the record. He was invited to testify today but unfortunately was unable to attend. So without objection, so ordered.

[The information follows:]

Written Statement
of

Robert Daniel Reisinger
Director of Engineering
6D Helmets, LLC.

Preventing Head Trauma: The NIST-NFL Head Health Challenge
Improved Protection using Omni-Directional Suspension (ODS) Technology

Before

The Committee on Science, Space, and technology, Subcommittee on Research and Technology, of the House of Representatives

December 13, 2017

A Review of the Head Health Challenge, a public-private science prize competition

Introduction

Hello, my name is Robert Reisinger. I am the Director of Engineering and one of two founding partners of 6D Helmets, LLC, of Brea, California.

I want to thank Chairwoman Comstock and fellow members of the Subcommittee on Research and Technology for the opportunity to provide my written testimony to you about the Head Health Challenge III.

My company, 6D Helmets, partnered with DRI for the Head Health Challenge III prize competition to develop a material, suitable for use in football helmets or other protective equipment, which can better protect against traumatic brain injury.

6D Helmets LLC is a privately held helmet design and manufacturing enterprise with ten employees founded in 2011 by Bob Weber and Robert Reisinger to develop advance technology helmets with broad range kinetic energy management systems, which led to the development of the Omni-Directional Suspension (ODS) technology. 6D Helmets is in its 5th year of sales.

Stage of Development

6D's Omni-Directional Suspension (ODS) technology was first developed in 2011 by 6D Helmets co-founders Bob Weber and Robert Reisinger, which offered up to nearly 80% reductions in energy transferred to the headform in some impact events compared to traditional motorcycle helmets. After extensive preliminary prototype development, laboratory testing and meetings with manufacturers, 6D Helmets' first production helmet, the ATR-1 competition off-road motorcycle helmet, was born. The ATR-1 helmet was an immediate success and gained rapid acceptance among motocross and off-road riders for its creative design solution to rotational energy management and improved performance over a wide range of linear impact events compared to contemporary off-road helmets.

In September 2013, a youth version, ATR-1Y of the successful ATR-1 was produced along with a downhill Mountain Bike/BMX helmet, the ATB-1, both of which incorporate the ODS technology.

In February 2015, the ODS technology was awarded US Patent Number 8,955,169 and all intellectual property rights belong to 6D Helmets.

In February 2016, 6D Helmets introduced a full-face street motorcycle helmet, ATS-1, with the ODS technology, as well as the first bicycle Trail helmet, the ATB-1T, with a new ODS design scaled down for the bicycle size helmet.

In February 2017, 6D helmets reintroduced its ATB-1T Trail helmet with the new ODS-2 technology influenced by R&D discoveries during the Head Health

Challenge III contest, which separated the linear and rotational design elements for individual control.

In February 2018, 6D Helmets will introduce its newest ODS-3 technology, which was influenced in its design features in part by R&D discoveries during the Head Health Challenge III contest. This new ODS-3 technology offers up to nearly 30% more energy absorption, in various impact events, over the original ODS design.

Head Health Challenge III

In January 2016, Dynamic Research Inc. and 6D Helmets LLC were awarded a $250,000 development grant inside the NFL's Head Health Challenge III (HHC3) to further develop the ODS technology for a multi-impact material solution. While it is common for football and other field stick and ball sport helmets to be designed with multi-impact materials, the motorcycle and bicycle industries primarily used single impact materials. Our goal for the HHC3 was to modify the design of the ODS system for football applications, use only multi-impact materials and gain individual control over the tuning of both linear and rotational impact attenuations. High order finite element analysis (FEA) was used by our team partners, Dynamic Research, to iterate through various design concepts and physical test coupons were constructed to compare and prove the FEA data.

Through these efforts, a modified version of the original ODS technology in test coupon form, per the requirements of HHC3, reached the advanced prototype stage in which several iterations of the design have proven effective at reducing impact forces sustained during both linear and shear-type impacts with multi-impact materials. We were also successful in separating the control features of the linear and rotational impact energy attenuation giving us separate control capabilities.

My Involvement

My involvement from the outset of 6D Helmets has been the Chief Technology Officer bringing my past experiences in the field of engineering, manufacturing and suspension system designs to bear in helmet technology to address the growing knowledge of what helmets are not doing, and need to be doing, for brain protection over the antiquated design parameters of today's test standards, and yesterday's helmets, that focused primarily on skull protection. The ODS design used in the HHC3 program is one of many design iterations that I had been processing over a few years. The HHC3 was the catalyst that provided the opportunity to bring this new concept to the physical world. One of my primary roles is to create and conceptualize technology solutions that are manufacturable. Another of my roles is to guide and lead our team through the design and implementation process of the new technologies. With the help and advance analysis capabilities from our team partners, Dynamic Research Inc., we were able to collaborate on the design modifications needed to continually

improve, through each iteration of physical test coupons and the FEA modeling, the performance of the new ODS system.

6D Helmets' Involvement

From the beginning, 6D's involvement was to supply the intellectual property, CAD designs models and was responsible for creating the fabrication process to make the test coupons for the joint effort between 6D and Dynamic Research. 6D created the initial concept test coupons to submit with our application to the HHC3 committee for the grant, as well as, created all of the grant period test coupons. 6D work with our specialty material suppliers to obtain various multi-impact materials. Through physical testing at our team partners, Dynamic Research, we determine the best performance of the initial test coupon design and submitted it to the HHC3 committee for our baseline sample. Once awarded the grant, and grant testing protocols defined, we created a new and improved design in CAD and provided the CAD design with the design intent to our team partners at Dynamic Research to be processed into their high order FEA analysis software for iterative design and parameter testing.

In addition to the physical testing and FEA analysis at Dynamic Research, during the development process 6D conducted impact testing of various materials in relationship to the material properties and its geometric shape to better understand the response characteristics of additional materials and shapes not being used in the FEA analysis. 6D created a testing protocol to evaluate numerous materials in various geometric shapes. 6D CAD designed these new test coupons to be custom machined at a specialty vendor skilled in the unique process of machining foam materials. 6D conducted impact testing on these new material coupons in the various geometric configurations to establish the response characteristics.

Obstacles and Challenges

As with any new adventure into the unknown there are always the unexpected events to overcome including technical and operational. Since this "Challenge" had not previously been conducted some of the testing parameters had yet to be defined at the outset of the Challenge. As well, given that rotational testing is difficult in and of itself, and it has many variables that need to be addressed to limit deviations, it is challenging to control the process for repeatability compared to linear testing. Also, given the fact that there is no one set universal testing protocol for rotational testing at this time that is accepted by all, it was hard to know exactly how to design our energy absorption system for maximum performance without clear parameters.

Fortunately for our team, we have been conducting physical rotational testing for the previous six years prior to the HHC3 contest, so we decided to initially stay true to our roots, and assumed that we were designing our system for a helmet

environment and would use impact energy analysis as such. We also chose to use the rotational testing protocol that we had developed over the previous six years for physical testing to maintain an understanding of the expected outcome of the testing data. As more testing parameters became clear from the HHC3 committee, we aligned our design and testing to meet the protocols of the Challenge.

Purely from a helmet designing perspective, some of the testing protocols presented by NIST to be conducted seemed out of line with the dynamics of various types of helmet impacts that might occur. However the HHC3 contest was not specifically defined for helmets, but moreover, generic energy management materials. This was a loose definition to the desired contest outcome that was not focused on a particular type of impacts event that define a specific goal, which left our team to itself to pick a particular direction for the impact event type. When designing for energy management one needs to understand the impact event related dynamics since they differ by the types of impact events. That is to say, a helmet with a head in it has different impact dynamics than a football field surface, a rubber motor mount or a ballistic blast wave. The dynamic events that occur in each type of impact event need to be considered to maximize the performance of the energy management system. I believe that a focused goal for the Contest outcome, opposed to a "grab-all" let's see what we might discover from a broad request, would be more efficient for the participants and more affective for the contest outcome expectation. I can only assume that the other contest participants made similar choices to pick a particular type of impact event to model their particular technology around.

Use and Benefits of Science Prize Competitions

We only need to look at historical event to see that innovation does not lie within one geographical location on the planet, with just one group of people or one organization. Necessity is truly the mother of invention. However, I believe more powerful than necessity is the desire of creative minds to overcome and solve a given challenge, which once identified, brings out an endless volume of ideas that only need to be acted on to vet out the solutions. Science Prize Competitions offer these opportunities to advancement by utilizing the mind power found in all corners of the world by presenting problems to the population in the form of a challenge. By providing the basic funds for these creative minds to act upon those ideas, that would otherwise be left to die nearly as fast as they may have been conceived, advancement is made. Guided processes like the HHC3 are functional in vetting out large volumes of idea submissions, and then distill those ideas down to a smaller group that seemed to have the best possibility of success, and then fund them.

6D Helmets is no different from many of the dreamers of the world, in that, we are a small company with limited funds to act upon the various ideas that we have, and had not the HHC3 program come around we would surly have been

delayed in discovering the ever growing depths to understanding our own technology and how we might use it to solve more problems. Everybody has ideas that come and then soon fade into the past if not acted upon, but having the resources to act on those ideas is crucial to giving inventors the inspiration and hope that their ideas may be the winning answer to the problem. Industry, academic and government entities can all benefit from providing the resources to be utilized by appropriate participants to help solve these problems.

Recommendations to Federal Government Participation

I believe that the federal government is using funds at one of the most efficient and effective ways possible when engaging small private sector businesses and inventors on development projects like the HHC3. I also believe that technical progress from these contests could be more efficient and effective if the winner of the contest had opportunities to receive significant funds after the contest to proceed onto future development activities opposed to a small award.

Business is expensive but big business and governments arguably spend tax payer's money in the least effective manner. If the goal of the federal government is for technical progress, then funding projects further after a winner has been selected seems only prudent to get the value from the contest activities. As an example, if the goal is for better helmet technology it would seem to be more effective to target several of the leading helmet technology companies to produce new helmets, give them a goal and the funding to deliver a better helmet in a three to five year window. This is much like the government's activity with aerospace projects where the companies are funded to do the development and then awards for production are given to the wining company. These companies could then assign dedicated teams and resources to the project to get the work completed without the loss of momentum. Funding research like the HHC3 but not funding the winning technology and company to go forward and do something with the new found technology seems counterproductive.

As well, in my opinion, it could be argued that giving $5 million dollars to several leading helmet companies to develop new technology over a three to five year period would cost less and provide more solutions and improvements, sooner than later, opposed to giving out many small amounts to various incremental contest recipients without a go forward funding plan.

It should be noted that keeping the process as simple as possible to allow each contest entity to use its particular strength to the fullest, without encumbering the process, is key. This is to say, academic and government entities tend to not be efficient at processing activities and tend to bog the processes down in "red tape" and internal agendas, and it would be best to operate more like a private sector company that needs to perform each day or die on the vine. Inventors and small private sector companies have to produce profits each and every day, especially small entities that are less than 25 employees, and long drawn out decision

making and red tape is counterproductive to the goals of progress. The HHC3 program was ran fairly efficiently with its structure that appeared to be private industry companies driving the process, with the government involved only in testing and final review. From a small business perspective, the system to fund and operate these contests should be kept as streamlined as possible to maximize the outcome of progress.

Thank you for your time and this opportunity to make my comments.

Robert Reisinger

Bio

Robert Reisinger, 6D Helmets LLC

Robert Reisinger is co-founder and Director of Engineering at 6D helmets LLC. Along with Bob Weber, Robert came up with the concept of the ODS™ technology and developed the technology from concept to full scale helmet production. Prior to forming 6D Helmets in 2011, Robert founded several entrepreneurial consumer product design and manufacturing companies spanning a twenty year period within the bicycle and motorcycle industries that produced various products, some of which are in the San Francisco Museum of Modern Art and the Bicycle Hall of Fame Museum. Robert was a part time lecturer at Cal Poly State University, San Luis Obispo, Ca, where he taught courses on manufacturing engineering, CAD/CAM design and CNC fabrication. In addition to his engineering expertise, Robert was a top professional motocross racer and R&D test rider. Robert holds licenses as: Commercial pilot airplane & rotorcraft, A&P aviation mechanic and general contractor.

Chairwoman COMSTOCK. And I now recognize myself for five minutes for questions.

Mr. Springs, I really appreciate your goal of becoming the most advanced impact protection company in the world and having it right in Loudoun County in the 10th District. You know, we know how important this is in sports, but as number of you have mentioned, head injuries particularly in construction continue to be a serious issue, obviously, our warriors, accidental falls are a problem with the elderly, and so these innovations that your company is working on, can you draw on a little bit how they are going to be applicable to preventing head injuries in the workplace, in the military, in homes, in healthcare settings? And then I'll just add a little bit, too, also about how we sell changing this concept to teams and team sports and how we move that in and get people to adapt, maybe engage parents and sort of a community engagement on this and understanding the issue.

Mr. SPRINGS. Right. When I founded Windpact, I believed there was an opportunity to bridge the gap because I spent several times listening to the hearings on concussions and traumatic brain injuries, and I believed there was a real opportunity because innovation had lagged for 30 years in football. There needed to be a bridge between what the really smart people like many of these panelists here today who were trying to figure out how the brain works on rotational impacts and how you lower peak linear accelerations, and the guys who are building products—companies like Riddell.

I believe that there still is a knowledge gap. My goal when I started Windpact was take our technology, learn from the smart doctors and some of the researchers at places like NIST, take those learnings and findings, apply our technology to build safer helmets. So we consider ourselves an ingredient brand. We work with large host brands in retrofitting their old solutions with our new technology to make their product better for the consumer. Basically, we try to make sure we understand what the medical professionals were saying, as well as the parents and others who are buying the product for their kids.

Chairwoman COMSTOCK. Great. Thank you. And, others, if you'd like to engage on that question, how do we sell this to the public at broad and understand all the cross benefits from it in so many different areas? Sure.

Mr. KEBSCHULL. Yes, if I may, one of the things that has become clear to me is that these kind of innovations have a lot of spillover into far greater areas than what we're really targeting. I mean, in the Head Health Challenge III we were targeting football helmets was really kind of our main focus, maybe other protective equipment as well, but we started brainstorming other ideas where this kind of material could be used, and we were coming up with things like roadside barriers, you know, protective equipment for the—where there are construction zones and things like that, which are hazardous areas right now. And we think our material concept can be applied to those other areas as well, and to date, nobody's really started talking that much about that kind of approach.

Chairwoman COMSTOCK. Okay. And as another area, you know, we know links now from head injuries and dementia and even pos-

sibly Alzheimer's. Is this another area where, as you have that improvement, whether it's in sports or other areas, that it also has that down-the-road impact of maybe lessening what we're seeing in dementia or Alzheimer's to the extent that we have knowledge about that now?

Mr. KEBSCHULL. Yes, I was talking to a medical doctor who was working in the field of brain trauma, and they're approaching the concussion problem from another aspect, from kind of a nutritional supplement aspect that would—I'm not sure on the details—some kind of antioxidants that would protect against long-term damage from repeated impacts. But they were also hopeful that that would apply then to Alzheimer's field as well, so it's possible that the plaques that are developing in the brain—and I don't understand all the medical issues very well—but those could be protected by this same kind of nutritional supplement that could protect concussion injuries as well.

Chairwoman COMSTOCK. Excellent. Anyone else want to jump in?

Dr. Dehgan, I just wanted to thank you. I loved your characterization of how you—you know, for us incentivizing the needle to find us and really getting outside the box on this, so I thought you really captured that well, and I think the importance of this is capturing the public's imagination. And, Mr. Springs, bringing your experience into it I think really does kind of sell the idea to the public at large in so many areas, so thank you for vividly, you know, describing that and capturing that for us. Thank you.

I'll now yield to Mr. Lipinski for five minutes.

Mr. LIPINSKI. Thank you. As I mentioned in my opening statement, federal funding for R&D traditionally comes through grants and contracts, investments in research and infrastructure, and I don't think I want anyone to think listening to this hearing that we are suggesting otherwise, that this is just an easy way to save money because I think it's important that we keep funding to the way we've traditionally done the funding. I think this is just a way to add to that to really unleash and find in places that we would—someplace we would expect to find them and we're not finding as much as we have—you know, as we should be able to I think in our research universities to sort of unleash that—you know, the entrepreneurial spirit there and all the way, too, as Dr. Dehgan talked about, the auto mechanic in Argentina coming up with a solution through a challenge. So I want to start out by asking Dr. Dehgan. To what extent and how should agencies integrate prize and challenge competitions into this broader federal R&D?

Dr. DEHGAN. It's a phenomenal question and important. The standard for us is they should be used when there's a clear and measurable outcome defined in advance, and in particular where the objective is clear but the way to achieve it is not, right?

And it allows us to do one thing. There is this incredible democratization of science and technology that has happened, just the prices of processors and the power of processors and memory and—has increased exponentially but decreased exponentially in cost. We have incredible opportunities for iteration of design thanks to additive printing. We have greater connectivity and access to knowledge ever than before. That has allowed for a greater democratization of science and technology. That allows us to capture many

other people, but we still need basic research to be able to create the underlying basis for that democratization of science and technology.

We still need to advance what we are doing in creating the diversity of potential solutions and the advances of knowledge to be able to solve many of these problems, but we can harness them in new ways and in complementary ways particularly where we are stuck on a particular problem or where that problem has tended to focus on a single discipline where we can cross and capture the potential of other disciplines to help contribute to solving that problem.

And that's where I think prizes and challenges work really well is where do we want to capture the democratization of science and technology? Where do we want to actually make use of the existing funded research and particular broaden the number of disciplines that are involved beyond it, where do we want to actually inspire the public, and where can we actually unlock private capital? Because I think that has been one of the great things. The DARPA Grand Challenge for the self-driving car was for the marines, but the application is a revolution that we probably couldn't have foreseen or DARPA couldn't have foreseen 13 years ago.

Mr. LIPINSKI. Dr. Dehgan—and I also want to ask Dr. Fasolka—any recommendations on what can be done better by federal agencies to design these challenges?

Dr. FASOLKA. This being the first challenge that we did under the new authority under AICA, NIST really learned that having a community of practice within the organization that really knew a lot about how to implement the authority, how to use it to work in a private-public partnership, how to effectively communicate the challenge to folks. That was what we learned at NIST is that having in terms of advice that you can get, guidance that you can get or how to implement these challenges, there's a lot more out now than there was when we started. So what we learned is that the more that you know about how to get into these things and properly manage them, it can stop—some of the things that we did when we started, We were going to for the first time give cash, for the first time work with—in a public-private partnership, for the first time do something where NIST would be receiving materials to test. And so it took us a long time to get up to speed and actually launch it and probably longer than we expected going into it.

Mr. LIPINSKI. Dr. Dehgan?

Dr. DEHGAN. Yes, so elements of good design, I think this idea of a challenge creating a community of practice is really important because what you're trying to do is create an ecosystem of solutions. And I think we have focused on the competitive aspects of challenges, but there's also collaborative aspects of challenges. How do you advance knowledge overall in terms of what you're trying to do? How do you actually capture the losers in the challenge and make sure that they benefit? Scale has to be built in at the beginning within what we're trying to do, so thinking about what happens after the challenge, how do we benefit the companies that are taking on these solutions and helping them implement what they're doing into helmets, into every aspect of American life is really important. Leverage is great and leverage allows you to mitigate risk

and have greater impact, so thinking about who your partners are within you doing the challenge.

And then even things like—it is clear that money is insufficient by itself—is one great benefit of potential challenges but, as Mr. Springs pointed out, the recognition is really important because that can untap investment. That can bring credibility to people, so thinking carefully about the prize purse and the benefits are critical.

And one of the things just to recognize about challenges—and it's a limiting factor—is we are shifting the risk. Because it is pay-for-performance, we're shifting the risk on the innovators, right? We're asking them. So the benefit that we are providing them has to be commiserate with the risk that we're asking them to take within it.

And the last—just two other things. I think we—our prizes and challenges should be audacious but achievable, so we do want to inspire that public imagination that Chairwoman Comstock talked about. And the other piece is that even failure is instructive. The first DARPA Grand Challenge no one won, right, but we have a self-driving car industry because they continued to do that two more times and learn from that.

Mr. LIPINSKI. Thank you. I yield back.

Chairwoman COMSTOCK. I now recognize Mr. Marshall for five minutes.

Mr. MARSHALL. Thank you, Chairwoman.

I continue to believe that innovation is going to do more to drive the cost of health care, the money spent on health care, down than any piece of legislation that we can write. And this is one more example. If these concussions weren't happening, we wouldn't be spending money on MRIs and CAT scans and ER visits and overnight stays at the hospitals.

I think I'll go with my first question to Dr. Fasolka. Like many of us, we've had children play football. My youngest son, an all-state running back, not quite as fast as Mr. Springs or quite as big but was certainly a great football kid—had three concussions. Those were some of the longest days of my life watching my son not be himself, not knowing maybe who he was, where he was, just kind of in a third world almost. And at the time I did research. Other kids with concussions and it was—Kevlar was about the only thing on the market that I saw, so my question for Dr. Fasolka is how much better are these new materials than Kevlar is, 20 percent better, 100 percent better? If you—you're the—go ahead.

Dr. FASOLKA. The measurements that we did in our challenge prize showed that compared to baseline materials, the kind of foams that Mr. Kebschull mentioned, that they could improve impact absorption sometimes 80 percent better than what we saw in the sort of old technology. But what's more important is the ability for the material to mitigate these rotational forces, these shear forces. And this is really the thing that makes these new technology special.

Mr. MARSHALL. Did you measure Kevlar as well? Was that one of your base materials that you tested?

Dr. FASOLKA. No, the baseline materials that we tested were basically foam rubber that you would see in a helmet technology, so just the pad——

Mr. MARSHALL. The traditional——

Dr. FASOLKA. —right?

Mr. MARSHALL. The state-of-the-art helmet?

Dr. FASOLKA. State-of-the-art helmet.

Mr. MARSHALL. Did anybody else test it against Kevlar—I'm just curious—in anything? Okay—go ahead.

Dr. FASOLKA. Yes, Kevlar—I mean, we test Kevlar at NIST——

Mr. MARSHALL. Okay.

Dr. FASOLKA. —but usually, it's for ballistic protection.

Mr. MARSHALL. Okay.

Dr. FASOLKA. Yes.

Mr. MARSHALL. There was products on the market with Kevlar, and that's what I——

Dr. FASOLKA. Yes.

Mr. MARSHALL. —purchased and tried. That's the best thing I could find at the time. I'll go to Mr. Springs next. Tell me a little bit about turf material. Have you done any work with turf material and any thoughts on that?

Mr. SPRINGS. We have not done any work on turf material. There are companies who are innovating on new solutions that can go underneath the turf. I think Viconic is one that comes to mind that you might have seen in NFL commercials. I would say one of the things that's important from our perspective as a startup company is that innovation can be sparked by money and the partnerships, as well as the learning from NIST and universities like Duke—when we won the HeadHealthTECH challenge working with Duke University and those guys holding our hand through the process was really good. So it goes beyond money. It's about the partnerships and the relationships and the validation. Winning the award at Texas Medical Center as well, the validation helps.

Mr. MARSHALL. Certainly from my experience I think that 2/3 of the concussions I saw in football were related to the heads hitting—going backwards——

Mr. SPRINGS. Yes.

Mr. MARSHALL. —and getting hit, and I think that the incidence of concussions doubled when our high school went from a traditional field to a turf, and it's my belief there needs to be national standards of what this turf needs to be made out of and that you all should be testing it and saying, look, if we're going to subject our kids to this, that this is the standard. Is anybody seeing anything in your industry going towards that?

Mr. SPRINGS. Well, I think it's there. You've got to look at the turf. I think you also have to look at the rules of the game. I know that in the Ivy League, Dartmouth was one of the first schools who actually took tackling out of practice and reduced concussions by 70 percent, so as I see it—it's looking at the materials, the way the helmets being built, the surface the game is played on, as well as the rules of the game, I think it's a collaboration of all those things coming together.

Mr. MARSHALL. Is anybody else seeing as much work with the turf as they are with the helmets? I think it's half the—at least half the equation.

Mr. Springs, back to you. The NFL is certainly the gold standard, and all of us—Great Bend High School now uses a super concussion protocol. It's so much better than it used to be, and we are doing it by the book. There's no more pressure from the coaches that, "Hey, your kid's the star running back; he's got to get back in there for this big game." That stigmata has gone away. Is your impression of the NFL that maybe some of that traditional "You just got to toughen up and get back in there," do you think it's improving? Is NFL doing everything that they can do to help us lead the way?

Mr. SPRINGS. Well, I think the awareness at the parent level and at the youth level, moms are more concerned. Moms and the whole community as a whole are getting better in understanding concussions. When I came up, my generation, they would tell you to just sniff a little smelling salt and go back in. Now, I think teachers, parents, coaches, everybody who's involved with youth or kids playing a sport is aware of the seriousness of traumatic brain injury and concussions.

Mr. MARSHALL. How about the NFL? Do you think——

Mr. SPRINGS. But to answer your question——

Mr. MARSHALL. —what's the culture over there?

Mr. SPRINGS. —I think the guys who are playing in the NFL today are more aware of the seriousness of traumatic brain injury. We saw what happened a few weeks ago when Ryan Shazier was hit in the Steelers-Cincinnati game, and I believe every player is aware of the seriousness of sports injuries. I think the NFL is also doing its best in trying to educate the players as well.

Mr. MARSHALL. Chairwoman, can I have another minute since there's nobody else back yet? Or we can go across the aisle and come back to me if you want to if we have time.

Okay. I want to talk to the military just a second. I'm more concerned about mini-concussions, just a chronicity of mini-concussions than I am one big blow. And one of my theories is posttraumatic stress disorder may be related to this—these hundreds and thousands of mini-concussions. Have any of you done any research or what are we doing for our soldiers to help with those mini-concussions? I think you sit next to a tank or you're in a tank and a boom goes off, you can feel the force of it even though you have hearing stuff in but there's got to be just some incredible forces going on. Anybody touch the military more so? Go ahead.

Mr. KEBSCHULL. We did a little bit of work with military helmets in our impact test lab and in our other research, and military helmets are—most of the effort that goes into designing military helmets is for ballistics. And I think impact protection is kind of an afterthought. I don't mean to be too harsh on the people who do those helmets, but they have multiple pads in them, and those pads are Velcroed in so they're configurable. And you can imagine that in hot climates like Iraq or Afghanistan the soldier is saying I'm going to go with just—take several of the pads out of there and I'll get a lot more ventilation and it'll be a lot more comfortable. So I think there does need to be more research done on military

helmets with respect to impact protection and not just the ballistic protection.

Mr. MARSHALL. Okay. All right. Thank you, Chairwoman. I yield back.

Chairwoman COMSTOCK. Thank you, very instructive. I appreciate it.

And I now recognize Mrs. Johnson.

Ms. JOHNSON. Thank you very much.

I'd like to hear from each one of you as it relates to the topic since there are many questions now about injuries to the brain but I want to especially ask Mr. Springs. Mr. Springs, I know your father and his Dallas family extremely well, and you must be a very proud son.

The products that have been designed to attempt to avoid some of the injuries that have been talked about to the brain in the field of football, have you seen any results or have you been able to tell that you're on the right track?

Mr. SPRINGS. I believe there are companies out there in the last five years who have looked at the seriousness and are getting the push from parents to build better products, so I'm excited about the future of technology.

There's one thing I will say there. Innovation, in football particularly, has come a long way since the Virginia Tech standard. That came out only five years ago when the Virginia Tech star rating, which talks about the risk of concussion. When that came out, there was only one five-star and now there's 13 in football. I think other industries like hockey and baseball will follow suit as their standards and scoring systems to rate these helmets, it will continue to improve.

I will also say that more of these manufacturers are receptive or open to new innovation from the outside where maybe five years ago that wasn't the case. So I'm encouraged by the fact that there are large brands who are looking for outside technology like our technology and what 6D uses in their motocross helmets and their helmets as well. So I believe—I am encouraged that the direction of technology is improving. I do believe that we need to also update our standards so companies like Windpact and other companies who are innovating technology, the standards are on the same page and speed of innovation.

Ms. JOHNSON. Thank you. Any other comments?

Mr. KEBSCHULL. I would just like to follow up on what Mr. Springs said about the Virginia Tech star rating system for football helmets. That's another aspect where you're looking at a competition. It's not a prize competition, but it's a competition that results in better helmets. And standards alone are just a minimum bar that people have to meet in order to sell a helmet, and what happens when there's only a standard and no star rating system or other kind of competitive system is that everybody just gets themselves over the bar and they don't have this kind of innovation that develops better products.

Ms. JOHNSON. Thank you. Yes?

Dr. FASOLKA. The standards now, too, are really aimed at these sort of linear impacts still, and so this is one of the things that NIST would like to help with is to begin to help the private sector.

These are consensus standards from industry, so that body be able to underpin new standards with the new science that we're learning about how shear is important, rotation is important, and if they can properly measure that.

Ms. JOHNSON. Any other comments from anyone?

Dr. DEHGAN. Just one thought. I'm not an expert in football unfortunately, but one of the ways that we could use which is a subset of prizes which are called advanced market commitments as a way of doing—how do you deal with this challenge of standards being that minimum bar. So could—you know, how can the government actually work together to organize high schools, colleges, professional leagues to say we will buy all the helmets that are made that involve a 50 percent decrease in concussions.

The Department of Energy did this with rooftop air-conditioning units. They had the big box storse say we're going to create the incentive for a market if you guys can improve the energy efficiency of these units. Not a dollar of federal taxpayer funds were used in doing that, but there was investment that was created and a drive that was created to be able to meet those incentives because there was an established market. At USAID and Gates, we created the global vaccine initiative, GAVI, actually around the same idea to create an advanced market commitment for neglected tropical diseases, so this is one way to think about how we may get around that problem.

Ms. JOHNSON. My time is about expired, but I want to ask if—do you think that it's appropriate that some additional research be funded by the government since this is such a broad spectrum sport and not just football but—and we are seeing more and more questions about the injuries to the point where parents are beginning to be a little skeptical of their children going into the profession. It does concern me. I'm a strong Dallas Cowboys fan from the beginning until now, and I know that this is mostly Redskin country, and I do pull for Redskins now and then when they're not playing the football team called Cowboys, America's team, but I really am very interested in this because I think it does have a very wide interest of the public. Thank you.

Chairwoman COMSTOCK. Okay. Thank you. I now recognize Ms. Bonamici for five minutes.

Ms. BONAMICI. Thank you very much, Chairwoman Comstock and Ranking Member Lipinski, for this good bipartisan discussion. I really appreciate it. I want to just first mention I appreciated the discussion between Mr. Marshall and Mr. Springs. When I was in the Oregon Legislature, serving on the Education Committee we had this very poignant hearing where a father came in and his son was basically unable to continue learning, had serious brain injury. He thought it was because of the helmet, but after many hearings and talking with healthcare experts, it's because he had multiple concussions and was sent back into the game after his concussions had healed.

And we ended up actually passing a requirement that someone with training in concussion identification had to authorize a student to go back into the game. And lest anyone think that people complained about that being overregulation, the coaches really appreciated it because it got them off the hook. There wasn't the pres-

sure. They could say, "I can't send you back into the game because I have to have this expert opinion."

But then I also wanted to follow up on the conversation about the troops and—that Mr. Kebschull was talking about and how do we make sure that our troops get the protection they need and deserve. And it reminded me of visiting Oregon Aero, which is a company in the district in northwest Oregon I'm honored to represent. They make seating systems for aircrafts and also make ballistic helmet pads and liners.

And when I was out there touring, talking with them a while back, they were mentioning that the military used to buy the product but then they found something less expensive. And then they showed me. And in fact I was just looking at the current blog. There's a nonprofit organization that was founded to help get their product to the troops because our military is not buying them because they found something less expensive. There are so many complaints. The current helmet pads—troops are complaining they're stiff, they give them headaches, they don't make the helmet fit properly, they get too hot, they get too cold, so they take them out, and then they're at great risk. So this nonprofit was formed to help get the pads to the troops because they'll leave them in. They can wear their helmets and protect their brains, and they've now—this nonprofit organization has now sent more than 88,000 of these upgrade kits to our troops overseas, so that's not really the best model.

So I guess my question maybe to the panel is when there is something that's a good product like that, how do—you know, making change at the Department of Defense and the Pentagon is really not that easy. How do we make sure that our troops are getting what they need? And maybe NIST can start. How do we convince the Department of Defense if there's a product that's really helping? Maybe it's a little more expensive, but taking care of brain damage is really—and PTSD is really expensive as well.

Dr. FASOLKA. Well, we have talked to the Army in particular about this, and they are aware that the technology in the helmets right now for this kind of padding is out of date. I think that this is one of the reasons why this challenge is important, these kinds of challenges are important because of this broad effect that they can have by bringing innovations forward. And so they're quite interested in learning about what came out of ours.

Ms. BONAMICI. I'm glad to hear that because it was a while back when I was learning this from Oregon Aero. And so they've known that they've been out of date for a long time, so I'm just saying we need to have a conversation. And hopefully the work that you're doing is going to help with that.

You know, we here in Congress have an app challenge, so certainly—I have seen just from the very small scale congressional district high school students who submit their innovation to the app challenge, we know what can come from this sort of competition and prize. But one of the concerns at that level I always think, "Oh my gosh, who's going to judge this?" How do you—in a prize competition like this, how do you set up the metrics for, you know, clear expectations and success? And then how do you deal with

things like intellectual property rights? So I'll let, you know, all of you address that as well.

Dr. FASOLKA. So we thought a lot about this of course, and so we had some metrics that were real scientific metrics like you'd see in a grant. What's the level of innovation? What's the level of being ready to be commercialized? Then we had a lot of hard numbers in the competition as well. They had to take 1,200 hits without failing. They had to work at hot and cold temperatures, so to really think about, well, what's the environment that these materials have to be in?

In terms of intellectual property, yes, there was no interest in the government from our perspective in acquiring anything. This is their property. Our job was to spur innovation, so that's an easy answer for us.

Ms. BONAMICI. Well, as my time is expired, I just want to close by saying that we are a country that is proud of its innovators. And this type of prize and competition is certainly one step, but there's a lot of other things we can be doing.

And I know Ms. Johnson mentioned the graduate students' tuition waiver and the tax bill. I'm happy to say that at least after the vote, many members who actually supported the bill have sent a letter now opposing the repeal of that income exclusion for tuition waiver. So we can't inhibit our young people and our students from becoming innovators who may solve these next challenges. So I hope that whatever tax bill comes out fixes that as well.

So thank you, Madam Chair, and I yield back.

Chairwoman COMSTOCK. I thank you. And actually I recognize Mr. Marshall for one more minute, another question.

Mr. MARSHALL. Sorry, I'm pretty inquisitive.

Chairwoman COMSTOCK. Dr. Marshall, sorry.

Mr. MARSHALL. That's all right. Wichita State University has a creation center, and they are able to use artificial intelligence to—in their case to say design the perfect, most structurally sound wing for an airplane or a jet with the least material. And I'm just curious if you've tried to use artificial intelligence to drive the perfect helmet, the perfect turf, the perfect—what we're trying to get at here if you guys are using artificial intelligence in any way in your companies?

Mr. KEBSCHULL. Well, it's not quite artificial intelligence in the traditional sense, but we did have an optimization software and an optimization procedure which seeks to find the path to the right material. So we're—we input—the inputs to it are the parameters and what ranges you'll allow it to have, you know, between the stiffness of X and Y or a dimension between A and B and so on. And then the software will run multiple, multiple simulations in order to try and find the optimum solution, so it's a way of optimization that's a little bit different than artificial intelligence, but it's maybe a little bit along those lines.

Mr. MARSHALL. I think the shear force is especially—the artificial intelligence may be able to help us to figure out not just what material but how to place it. Dr. Fasolka, are you guys doing anything at NIST with it?

Dr. FASOLKA. Yes. The place for artificial intelligence at NIST is really within the Materials Genome Initiative, which is——

Mr. MARSHALL. The what, I'm sorry?

Dr. FASOLKA. The Materials Genome Initiative.

Mr. MARSHALL. Okay.

Dr. FASOLKA. It's a multiagency initiative. It's DOD, DOE, NIST, NSF really aimed at accelerating materials design and deployment. And using these kind of techniques so that the idea of course is to have a design-forward sort of approach, a lot of computation, ways of optimizing it. Artificial intelligence is sort of a continuum from of modeling to something that really looks like a human brain thinking about things. But in the middle, you know, we're using these very clever computational techniques to get to an optimum——

Mr. MARSHALL. Yes.

Dr. FASOLKA. —so we are partnering as the next step in our research using Materials Genome Initiative approach with our Center of Excellence and the Center of Excellence for Hierarchical Materials Design in the Chicago area to really have a Use Case that can use these kind of artificial intelligence approaches to design materials that do exactly what you're talking about, really optimize the shear response, optimize while keeping that compression response. So yes. So that's what we're embarking on next.

Mr. MARSHALL. Thank you.

Chairwoman COMSTOCK. Thank you. And I now recognize Mr. Lipinski for some additional questions.

Mr. LIPINSKI. I thank the Chairwoman for yielding the additional time here. I wanted to follow up. I asked Dr. Fasolka and Dr. Dehgan about anything—any recommendations they had for what the—what federal agencies could do better in designing these challenges. So I want to ask Mr. Kebschull and Mr. Springs if they had any thoughts on the design and also the, you know, follow up of the—of challenges, if anything could be done better. So, Mr. Kebschull?

Mr. KEBSCHULL. Yes, thank you. From my viewpoint it went extremely well. The one thing I would've probably preferred was to see perhaps clearer targets being set. We were given a very vague direction in that make your material better, make it perform well in linear and shear impacts, but we didn't really know how good is good or what is it that—exactly that you're looking for. And, for example, the shear test was not developed until pretty well into the process, so I kind of felt like we were playing catch-up along the way. But overall, I have mainly good things to say about NIST because they were really helpful in getting us the data that we needed in order to validate and use our computer simulation models.

Mr. LIPINSKI. Mr. Springs, anything that you would care to add?

Mr. SPRINGS. Yes, to follow up a little bit on that is kind of what you said, Dr. Dehgan—did I say that correctly? It might have been a lot of tackles. Clear and measurable are the words I heard, and that's kind of as a young company you want to be exact—because your resources are limited, you want to be exacting on what you're trying to achieve, what the outcome may be from the funding, or what you can ask for. And I think that's critical for any company just have a clear understanding of what it takes or what are the measurables or what you need to get to solve for, the steps you

need to solve for, and just make it clear and easy so that everyone can understand it.

Mr. LIPINSKI. All right. Thank you.

Chairwoman COMSTOCK. Well, thank all of you. This has been a great hearing. I really appreciate all your expertise. Thank you for your testimony and the Members for their questions.

And the record will remain open for two weeks for additional written comments or written questions from Members.

And this hearing is now adjourned.

[Whereupon, at 11:27 a.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Michael Fasolka

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

Dr. Michael Fasolka, Acting Director, NIST Material Measurement Lab

Questions submitted by Chairwoman Barbara Comstock, House Committee on Science, Space, and Technology

1. What are your thoughts on the website challenge.gov, which is meant to announce and track federal prizes? In your opinion, has the website been effective? Are the competition announcements reaching the right audiences? Please share any recommendations for improvements you may have.

   Answer: Challenge.gov is essential for NIST as the location for announcing all prize competitions under the requirements of 15 U.S.C. 3719. Some of NIST's prize competitions have been hosted on challenge.gov, which provides simple, easy to use interface for posting information, hosting discussions with participants, and collecting submissions. Challenge.gov reaches a broad audience but does not specialize in one type of challenge or community because of the breadth of federal challenges. To ensure that competition announcements reach the right audiences, NIST sends targeted announcements to potential communities of interest via mechanisms including social media, workshops, and listservs in addition to the posting on challenge.gov and social media outreach provided by the team at challenge.gov.

2. In your testimony you mentioned, as part of the Head Health Challenge, NIST's Material Measurement Lab developed novel testing to measure the forces exerted on material due to rotational impacts. Was NIST aware that these capabilities would need to be developed when agreeing to participate in the Head Health Challenge?

   Answer: Yes, and that awareness reflects the NIST mission: to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. NIST addresses difficult measurement problems that no one else has the resources or expertise to tackle. While awareness of brain injuries from rotational forces has increased, assessment of rotation and impact at the same time (as might happen in a blow to the head) is a complicated measurement. Subsequently, these forces have not been widely evaluated in today's protective equipment. NIST saw that gap and committed to the development of a new measurement capability when it agreed to partner in Head Health Challenge III.

Can you please elaborate on what these new capabilities means to the lab and how else they could be used in the future?

Answer: NIST will continue to refine the measurement methods that it created in this challenge and hopes to share its expertise with standards-setting organizations that are considering new generations of protective gear. In addition, NIST has worked with the University of Virginia, particularly on the new technique that NIST developed to measure the combined forces (compression and shear) that occur during rotational impacts. Under Armour also provided feedback on the test. So, some transfer of technology from NIST to non-governmental organizations has already occurred.

In addition to the new capability for measuring rotational forces, NIST modified and improved some of its existing test capabilities for Head Health Challenge III, and continues to measure impact-resistant materials. Informally, NIST has talked with the Army Research Laboratory and the Consumer Products Safety Commission about integrating materials testing into evaluations of impact-resistant systems.

NIST has also begun a use case to apply a materials genome approach to impact-resistant materials with the NIST-funded materials center of excellence, Center for Hierarchical Materials Design (CHiMaD), to develop new ways of designing and constructing materials that dissipate energy in ways not possible with today's materials. This effort will provide new and innovative approaches to impact mitigation.

How will these new measurements change private industry's testing and setting of safety standards for protection products?

Answer: As a non-regulatory federal agency, NIST does not set or enforce standards. NIST does, however, contribute its measurement expertise and technical results so that industry-led standards-setting bodies can make science-backed decisions by consensus. NIST intends to inform the community of its new measurement expertise and share data for rotational forces measured in non-proprietary materials. NIST experts serve on the ASTM International Committee on Sports Equipment and Facilities, which sets voluntary standards for the performance specifications and test methods for a wide variety of helmet types. NIST routinely meets with the Consumer Products Safety Commission to discuss issues related to testing protective equipment, and plans to work with the National Operating Committee on Standards for Athletic Equipment (NOCSAE) to assist with the continued improvements to the test methods and performance requirements for football and other helmets.

Can you think of other science prize competitions NIST could sponsor that would spur this type of innovation both within NIST and the private industries competing in these competitions?

Answer: NIST is continuing to explore opportunities where its programs would gain greatest benefit by using prize competitions. Under the leadership of the NIST Director, the NIST programs are seeking to identify prize topics where the competitive award of a prize will stimulate innovation in support of our mission.

3. As stewards of federal tax dollars, it is essential to ensure that federal science prize competitions are an efficient and effective tool for spurring innovative solutions. How does NIST measure the impact of a prize after the competition? What are some metrics that are or should be measured? How can agencies work with the prize winners to measure the impact of the prize after the competition?

   Answer: After the prizes are awarded, the competition enters the "Transition" phase, as described on the challenge.gov toolkit (https://www.challenge.gov/toolkit/transition/). In this phase, NIST documents the results and outcomes from each competition, which are shared with the White House Office of Science and Technology Policy for its report on federal prize competitions. The near-term impacts tracked include the number of participants engaged and solutions generated. Other impacts to NIST include the ability to reach out to new communities of solvers; broadening awareness of the NIST mission among our stakeholders and the general public; and helping to inform NIST research programs, as happened with the Head Health Challenge III and NIST's new research efforts supporting the measurement of rotational impacts.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

Dr. Michael Fasolka, Acting Director, NIST Material Measurement Lab

Questions submitted by Ranking Member Daniel Lipinski, House Committee on Science, Space, and Technology

1. How can NIST continue to iterate and innovate to refine or improve the federal prize and challenge model? Are there additional collaborative mechanisms through which the agency can improve the efficiency of prizes and challenges? Are there new models for running prizes that can unlock greater impact, and if so what are they?

   Answer: NIST will continue to use prizes and challenges as part of the portfolio of tools that it uses to advance its mission. NIST's experience with launching its own prizes continues to grow and through these competitions, and continues to learn and streamline how the model best works for NIST. 15 U.S.C. 3719 provides a number of collaborative mechanisms specific to prize competitions that NIST will continue to leverage and expand. The expansion of these mechanisms for more substantive and meaningful public-private partnerships is an evolving and growing model.

2. What ways can the innovations that come from a prize or a challenge be applied and brought to scale, and what is NIST's role in addressing this? How does NIST ensure that scale is factored into prize design? If prizes do not lead directly to the scaling of solutions, what organizations or tools can help complete the pipeline of innovation?

   Answer: After the prizes are awarded, the competition enters the "Transition" phase, as described on the challenge.gov toolkit (https://www.challenge.gov/toolkit/transition/). NIST uses the federal community resources provided here to inform its transition plans. NIST documents results and outcomes from each competition, which are shared with the White House Office of Science and Technology Policy for their report on federal prize competitions. NIST encourages continued research collaboration with participants from its competitions, as appropriate, for example by using Cooperative Research and Development Agreements (CRADAs). NIST's prize competitions have focused on the development and demonstration of new technologies and solutions to problems. To scale these concepts, non-federal challenge partners can present unique opportunities for future partnerships (i.e., Under Armour and GE in the Head Health Challenge III may work with participants from that challenge in developing future products). NIST provides opportunities for winners to meet potential customers/partners by presenting at major

events (i.e., winners of the NIST Unmanned Aerial Systems Flight and Payload Challenge will be invited to demonstrate their work at the Public Safety Research Stakeholders Conference this June).

3. The ecosystem or community around a prize or challenge is critical in spreading the word to those innovators who might be interested in competing. In fact, engaging with the right solver community is one of the most important tasks in operating a successful challenge. NIST has a history of engaging communities of innovators through challenges. What mechanisms are there to best cultivate communities of innovators such that they are ready to engage in prizes and challenges when called upon?

   Answer: Community engagement is essential and a continued challenge. NIST uses many mechanisms to reach its stakeholders, including social media tools and platforms, and traditional mechanisms such as Federal Register Notices, subscriber lists, focused workshops, discussions and presentations at related professional and technical society meetings, etc. In some topics, the community is well known to NIST because of its decades-long commitment in a technical area of focus. Public-private partnerships can greatly assist with outreach, for example the Head Health Challenge III followed two previous challenges that were issued by the NFL, Under Armour and GE as part of a larger program to build awareness and support head health. Video segments and interviews on news programs (both local and national) helped generate awareness of the Challenge and shed light on this important issue. NIST has also been able to expand its community of potential solvers by using administrators which are familiar with the target communities. Challenge.gov provides NIST a central location to post its challenges to make them accessible for potential solvers, and the challenge.gov team provides social media outreach.

Responses by Mr. Scott A. Kebschull

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

Mr. Scott A. Kebschull, Vice President and Technical Director, Dynamic Research, Inc.

Questions submitted by Chairwoman Barbara Comstock, House Committee on Science, Space, and Technology

1. What are your thoughts on the website challenge.gov, which is meant to announce and track federal prizes? In your opinion, has the website been effective? Are the competition announcements reaching the right audiences? Please share any recommendations for improvements you may have.

   Answer: In my view, the website has limited effectiveness. Mainly I believe the reason is that the breadth of topics is so great that it can be difficult to find the much narrower subset that is of interest to a person. For example, I am primarily interested in topics like head impact, crash safety, and occupant protection, but the website contains hundreds of topics from invasive mussels to sensing arsenic in water that are completely outside of my field.

   Although the website allows the sorting of the challenges by several broad categories, it may be more helpful to include dozens of keywords for this purpose instead. It would be a substantial undertaking to develop an appropriate list of keywords, but this might help the website's users find the challenges that interest them.

   Another way to reach the right audiences might be to ask the challenge sponsor to advertise the challenge in trade publications or on websites that are used by people in related fields. In my own experience, I often discuss the things I read with colleagues and share articles with them if I think they might find them useful. Ultimately, word of mouth is very effective, and advertising the challenges can stimulate those "word of mouth" discussions.

Responses by Dr. Alex O. Dehgan

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

Dr. Alex O. Dehgan, Chief Executive Officer and Founder, Conservation X Labs

Questions submitted by Chairwoman Barbara Comstock, House Committee on Science, Space, and Technology

1. What are your thoughts on the website challenge.gov, which is meant to announce and track federal prizes? In your opinion, has the website been effective? Are the competition announcements reaching the right audiences? Please share any recommendations for improvements you may have.

   Answer: Challenge.gov does a good job of announcing and promoting new challenges to its existing network. It is also a convenient platform for all agencies running competitions to use as a portal for those interested in and participating in the challenges. It is fairly user-friendly in that potential solvers can search by topics and digest the challenges in short easy to read card-like snapshots.

   However, Challenge.gov is a victim of its success. There are too many challenges listed on the site, including challenges with expired links. There were challenges on the front page of the site that were no longer accepting applications, and the challenges themselves suffered from inconsistent design and format, and sometimes lacked effective agency data.

   We propose a few recommendations to the challenge.gov site:

   (1) **Developing Algorithms for Promotion to the Front Page**. Following the crowdfunding model, challenge.gov should use the intensity of interaction and engagement with a challenge to move challenges to the front page as a default setting. The current setting focuses on the newest challenge, while users can search by a combination of the agency or the prize purse to identify challenges. Encouraging Agencies to "bring a crowd to build a crowd" pushes agencies to spend more effort on marketing the challenge, and helps create a live community for Challenge.gov that generates excitement. Agencies in this way can be rewarded for putting resources into engaging on the challenge.

   (2) **Improving Challenge.gov's Visual Design**. The value proposition of Challenge.gov is it allows solvers to discover and participate in Agency challenges, yet the site is deeply uninspiring in its format. Challenge.gov could learn much from advertisers and sites like Indiegogo which intend to draw people to the projects and build a community of funders. While many of the challenges are well designed on the Agency sites, there needs to be

more done around the design of the challenges on the Challenge.gov site. Some ideas could include integrating the Prizewire stories with the challenges, increasing interactivity and engagement, and creating a more visually engaging site with greater representation of imagery. This will require a larger staff dedicated to operating the site.

(3) **Creating a Home Page**. Challenge.gov needs a home-page, or landing page, that explains what Challenge.gov is clearly as well as what a user can do on the site that doesn't drop the user directly into the search page.

(4) **Creating a more tailored site**. While Challenge.gov allows you to select and follow challenges by Agency, it could also do so by subject matter or technology. The site could be "smarter" allowing it to suggest challenges for you based on your expertise, or knowledge, or sector, as well as based on other challenges you have taken on before. The site could borrow from algorithms used by Netflix or Hulu to propose potential challenges that would interest participants.

(5) **Create a marketplace of successful solutions**. We don't know what has happened to previous challenges, in the absence of a story on the site or prize wire, yet such stories and data could be valuable to investors, future solvers, and other agencies. We recommend creating opportunities for people to find out more about winners and losers, to help with the acceleration and scale up, as well as provide credibility to the challenges that encourages newcomers to engage? Challenge.gov could also benefit from having a separate section for closed competitions and winners (instead of bunching all 800+ announcements in one single space).

(6) **Expanding the Community**. Challenge.gov does a good job of announcing and promoting new challenges to its existing network, but may want to provide the tools to allow for reaching a broader network. The challenge.gov twitter account is pretty active, but could probably be even more proactive about alerting followers to deadlines, announcements, winners, etc. It isn't clear how many users regularly check the website, but some of the challenges do have a relatively active discussion board to ask questions and post comments about the challenge. The challenge.gov audience can probably be expanded, but this should be the responsibility of each agency organizing challenges.

Democratizing Challenge Design. The model behind prizes and challenges is to expand the pool of potential problem-solvers beyond the Federal Agencies. These prizes and challenges should be of shared interest by the public as the U.S. Government is a representative democracy where the public pays taxes in exchange for environmental protection, defense, education, infrastructure and social services. However the current model of prizes and challenges only allows for Federal Agencies to describe the problem, which becomes a prize or a challenge, and request solutions to that problem from the

public. This is a one-way flow in the ecosystem of problems and solutions. The public are oftentimes the closest to some of the problems that federal agencies are tasked with managing, not just the source of the solutions. Challenge.gov could include an option for the public to propose challenges for consideration by the challenge.gov community. Problems that rise to the top could then be suggested to Federal Agencies, which could be encouraged to refine them into a prize or challenge statement and posted on Challenge.gov.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

Dr. Alex O. Dehgan, Chief Executive Officer and Founder, Conservation X Labs

Questions submitted by Ranking Member Daniel Lipinski, House Committee on Science, Space, and Technology

1. How can we iterate and innovate to refine or improve the federal prize and challenge model? Are there collaborative mechanisms through which we can improve the efficiency of prizes and challenges? Are there new models for running prizes that can unlock greater impact, and if so what are they?

   Answer: When done correctly, prizes and challenges are significant tools for disruption and innovation, and can provide substantial cost savings to the government. However, many prizes and challenges fail to reach their full potential. We offer the following suggestions on how to improve on the execution of prizes and challenges.

   A. Advancing The Science of Innovation In Government

   There is a science of innovation, and in some ways, institutions like OSTP and GSA need to be not only helping with the execution of prizes and challenges, but studying them to understand how to make them better, in partnership with academic organizations. There is existing academic research around the process of innovation that across multiple disciplines, including within areas of study such as human-computer interactions, behavioral sciences, economics, marketing, and psychology. The goal is to harness learning and input from these disciplines, understand how they influence the execution of prizes and challenges, and iterate on the model.

   There are countless iterations that could be done on the prize model, and not all prizes need to look the same. Congress should encourage the experimentation with different forms of prizes and challenges (competitive processes) as well as collaborative open innovation mechanisms, with the goal of advancing innovation the improves the speed, efficacy, cost, and sustainability of solutions to the challenges facing our nation.

   B. Mass Collaboration

   The federal prize and challenge model encourages competition, but the model can expand to around mass collaboration. Mass collaboration allows solvers to build off of each other and ultimately the intellectual property doesn't belong to one or a few solvers. This open innovation model may allow for greater impact and scalability because the barriers

associated with intellectual property do not exist, so that, given the materials and resources, multiple entities can mass produce and develop the solution. The real-world example is Open Source Drug Discovery, where mass collaboration by pharmacologists and scientists led to the creation of improved drugs for neglected tropical diseases.

Moreover, the ability and value of prizes to induce innovation is observed not only in the winning entry but many of the other applicants ("the losers"). Prizes and challenges can be extremely wasteful in terms of their innovation power because 99% of the applicants are unsuccessful, but may have ideas or components of ideas, that if brought together, could be even more impactful than the "winners." Being able to harness the full innovation impact of prizes and challenges is critical to our success.

Conservation X Labs has created a mass collaboration site – called the Digital Makerspace (www.conservationx.com) that uses mass collaboration in combination with prizes & challenges (including ones we host on the site) to advance new innovations (including both open and closed Intellectual Property, IP), and then bring the best of those ideas to scale. We are integrating our prizes and challenges with this mass collaboration site to capture the "losers" of prize and challenge competitions, thereby increasing their overall efficiency by supporting many more potential ideas to get to scale. This can be a model or platform for the federal community.

C. Acceleration, Equity, and Unlocking Private Investment

Prizes and challenges are powerful mechanisms that advance and accelerate solutions at low cost, however, these innovation tools are not well integrated into the work of Agencies. Most solutions are not integrated into the Agency's core programming and work, despite the success of prizes and challenges, and the breakthrough nature of the innovations. There is a need to ensure those Agencies running competitions think and act beyond the prize and challenge competitions. However, given the short term political attention span of government agencies, they may not be able to do so.

Potential solutions are then to partner with the private sector, which can use a prize or challenge mechanism to take equity, ensuring an interest in the scaling of solutions, as well as providing acceleration support for winning ideas. Under a public-private model, federal dollars can be invested in running the challenge process, providing first loss guarantees on private sector equity investments, and funding and supporting acceleration processes.

D. Prizes for Behavior Change and Social Science Solutions

Another new frontier in the evolution of prizes is an attempt to break away from the notion that prizes are only effective for technological breakthroughs. Many prize designers are attempting to develop new models that will lead to behavioral changes and new social paradigms. Can we develop prizes that will can address addictions without

drugs, or encourage behavior changes that reduce traffic fatalities, improve energy uses, or improve health and longevity outcomes?

E. Increasing Demand for Innovation

Organizations running and implementing prizes tend to consider them as single one-off events, meant to capture the public imagination around a topic, and gain publicity and recognition for the agency for their innovativeness. As a result, most prizes don't generate new innovations that have been developed from scratch as much as they tend to encourage the novel applications of existing innovations to new sectors. However, when prizes and challenges are repeated (such as USAID's Saving Lives at Birth), this repetition creates a market signal that can induce innovators to create breakthroughs for a challenge. Other variations include taking a sequential approach to breakthroughs through multiple additive challenges, or creating tiered structures based on venture capital models of staged investment based on success (similar to the structure of USAID's Grand Challenges, or the Development Innovation Ventures) that help encourage scaling products.

F. Creating an Open Door for Innovation.

An alternative to a prize or challenge is to have an open door to a government Agency for new breakthrough innovations that are not driven by a particular topic (other than the areas where an agency works). USAID used this model with the Development Innovation Ventures, which allowed for innovations that the Agency didn't envision, and it invited interventions that could change millions of lives at a fraction of the usual cost to potentially get access for funding outside of traditional program areas or RFPs.

2. What ways can the innovations that come from a prize or a challenge be applied and brought to scale? How do we ensure that scale is factored into prize design? If prizes do not lead directly to the scaling of solutions, what organizations or tools can help complete the pipeline of innovation?

Answer: Scale is critical to the success of prizes and challenges, and must be considered at the beginning of any prize process, and into the prize design itself. It is insufficient to run a challenge without some understanding of what happens after the competition. Agencies should think systematically in terms of the ecosystem (who will buy the solutions, who will mass produce the solutions, who is willing to pay for the solutions), their business models (franchising, licensing, acquisition, or direct distribution), the scaling model (through the private sector, public sector, open source), potential barriers to market entry (regulatory barriers, societal or cultural barriers), and acceleration support (understanding their optimal value proposition, availability of mentors, overcoming technical barriers, access to investors and industries).

Scale can be part of the actual competition itself. It can manifest itself in terms of the design criteria for the innovation (ensuring the efficacy in the communities for which it is being used), through making part of the competition's requirement about reaching scale (e.g, production of 100,000 metric tons of fish-free feed), or ensuring the scale or adoption of the innovation as part of the prize of the competition, such as through an Advanced Market Commitment, a contract that goes into force guaranteeing a quantity of purchases if a set of performance criteria is met, or requiring acceleration as part of the prize (a great model for such programs includes the I-Corps program at NSF).

3. The ecosystem or community around a prize or challenge is critical in spreading the word to those innovators who might be interested in competing. In fact, engaging with the right solver community is one of the most important tasks in operating a successful challenge. What mechanisms are there to cultivate communities of innovators such that they are ready to engage in prizes and challenges when called upon?

   Answer: A robust solver community is actually a community of communities. Ensuring the reach of a challenge to new disciplines and solvers, as well as inviting experts and non-experts, is critical to innovation. Prizes must engage innovators who otherwise would be unlikely to tackle the problems that the prize is designed to address. Prizes must be designed to attract new people entering fields with nontrivial approaches, using new resources and collaborating in unique ways.

   Specifically:

   (1) **Prizes require a diversity of partners**. Prizes that are organized by institutions without a broad community of support are unlikely to reach across to new disciplines or sectors. Diversifying the partners allows for the ability to reach novel communities, mitigate the risks, and given the rarity of such collaboration, increase the uniqueness of the competition. This is especially true for prizes that can cross multiple disciplines or sectors. Such partners are not just branding for challenges, but have to participate in the design of the challenge itself. Innovation tends to happen at the boundary of fields, so breaking out of the tyranny of your experts is critical to success.

   (2) **Language is the signal**. The language of prizes and challenges has to signal an openness to new ideas, new solvers and communities. Prizes and challenges tend to undermine their own goals because they are trapped by their procurement processes, or by the culture of their agency or field. The prize language and call to action have to be clear, simple, and focused on the barrier that the prize seeks to overcome, without seeming to dictate a specific approach or solution, or using overly-technical language.

   (3) **Invest as much into the engagement as the prize.** Many agencies tend to put all their resources into the prize purse, without investing personnel or resources into the launch, amplification, engagement with the diverse communities that you want to

attract to the prize. There is a tendency to believe that if you build a prize, the innovators will come. In today's crowded environment of prizes and challenges, such approaches are unlikely to generate success.

(4) **Prizes must capture the imagination**. A prize or challenge crystallizes and articulates an issue in a way that is easily described and that engages the creative spirit of those who would participate. They are intended to move the needle in terms of potential solutions, demonstrate a breakthrough, literally showing that the impossible is now possible. A well-designed prize provides a motivating, meaningful target for interested teams, encourages creativity and inspiration, and can draw in new people into a field.

(5) **Think creativity about the Award**. Prizes and challenges inspire people for reasons that go beyond a financial purse, but also monetary prizes can help spur private sector action by offering a lump sum to winners of contests. Prizes may utilize other types of incentives and structures beyond monetary prizes, including recognition, advanced market commitments, media attention, and credibility.

Responses by Mr. Shawn Springs

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

"Head Health Challenge: Preventing Head Trauma from Football Field to Shop Floor to Battlefield"

Mr. Shawn Springs, Chief Executive Officer, Windpact

Questions submitted by Chairwoman Barbara Comstock, House Committee on Science, Space, and Technology

1. What are your thoughts on the website challenge.gov, which is meant to announce and track federal prizes? In your opinion, has the website been effective? Are the competition announcements reaching the right audiences? Please share any recommendations for improvements you may have.

   Answer: Until I participated in this hearing, I had no prior experience with challenge.gov. I did go in and try to register for an account but since I am not a federal government employee or a contractor with a valid government email address, I was having a difficult time registering. The registration process was confusing. In my mind, the website needs to be more user friendly. The idea of this site is appealing but I'm not sure that the way its set up currently allows for maximum exposure. In the future, I can see that this site might be valuable and I would like to learn more about relevant federal prizes that would be good for Windpact.

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