Witness Testimony of
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Chairman Baird, Ranking Member Ehlers, and members of the Subcommittee:

The Maryland Science Center, located at Baltimore's Inner Harbor, is a private non-profit that had its genesis in 1797 as the Maryland Academy of Sciences, which is still our parent organization. The current building was put in service in 1976 and expanded in 2004. The facility houses three levels of highly interactive, hands-on exhibits, a planetarium, an IMAX Theater, classroom space, and program space for live demonstrations on a variety of scientific phenomena.

Each year, Maryland Science Center welcomes over 400,000 visitors to our facility with about 100,000 students visiting with school groups to augment their science and mathematics curriculum. Major areas of concentration—our core programming areas—are earth system science, space and aerospace science, health sciences and the human body, and early childhood education. All of the permanent exhibits at the Maryland Science Center were designed to be in concert with the Maryland Department of Education Science Curriculum, and where applicable, under the influence of The Benchmarks for Science Literacy published by the American Academy for the Advancement of Science as part of Project 2061, the National Science Education Standards prepared under the auspices of the National Research Council, and the Principles and Standards for School Mathematics from the National Council of Teachers of Mathematics.

The Maryland Science Center, like hundreds of institutions across the country and around the world, employ what is known in the field as "informal education" as its means of connecting people with science and technology. Learning by doing is the foundation of

informal education, along with demonstrating practical examples. Building on that foundation, the role of the science center as distiller and interpreter of the latest in scientific discovery and connecting the public, especially school children, to the everyday application of these advancements, is a key strategy we employ. Showing how, rather than stating why, gives visitors the information they need to make informed decisions about how they can relate to the topic at hand. When we're successful, we go from global to local to individual along a continuum giving the individual the facts, a better understanding or how it relates to them, and hopefully, a quest for more knowledge. Science centers in particular have an ability to affect change by engaging school children through their use of informal education methods. Motivating students to take interest in science, technology, engineering and math, whether or not they choose to pursue a career in those fields, puts science centers in a unique position to spark an initial interest.

Collaboration has always been a means to an end for the institution. Seeking partnerships to ensure that our exhibits and programs are the best they can be has yielded quality educational and enjoyable product for our visitors. The Maryland Science Center has long cultivated a history of working with the National Aeronautics and Space Administration (NASA), National Oceanographic and Atmospheric Administration (NOAA), National Institute of Standards and Technology (NIST), as well as the National Science Foundation (NSF) and the National Institutes of Health (NIH). Working with these agencies, and others, we develop permanent exhibits, traveling exhibits, and programs designed to inform and educate the general public—from those school children to their parents and teachers—about not only the basics of science, math and technology, but also the latest events and discoveries in our core programming areas.

In our core exhibits we use high tech, multimedia update centers known as Links. Each Link is designed to offer real time investigation of science topics in the news that are appealing to mass audiences. When something happens in the world of science and technology, our Link areas and Link staff key in on the news releases, scientific data, and information resources to process and present the findings in a relevant, thought-provoking manner. Our Links are designed to give visitors who seek cursory, as well as deeper understanding of science as it happens, a chance to speak with our content experts, and to explore areas that can be a resource for the quest for deeper knowledge. Maryland Science Center currently features three Links. TerraLink focuses on earth system science, SpaceLink concentrates on space and aerospace science and BodyLink examines health sciences. The fabrication and design of these centers was accomplished with input from the aforementioned agencies, and we continue to interface with these agencies to stay on top of current research.

In the SpaceLink update center, NASA has been a primary partner. The partnership has taken many forms. With the Goddard Space Flight Center, we have helped develop an after school astronomy club format. The results can be seen at www.afterschoolastronomy.org. This site is a resource that provides information for students with an interest in astronomy and put the information to use in practical applications, a hallmark of informal education. We have also co-hosted individual events with Goddard such as Sun-Earth Day, where educators from Goddard are at the Maryland

Science Center to explain that we live in the atmosphere of a star, which has many effects on our planet. We are part of a larger system and understanding that system is vital to other scientific endeavors we attempt to explain. This is an annual event where visitors engage in activities and receive print materials to take with them that allow them to further explore the topics at home. Again, relevancy and real world examples—informal education in process.

Maryland Science Center and Goddard also co-hosted an Earth Explorer Institute where we convened 25 informal educators representing science centers and museums from across America to discuss and recommend NASA earth science programming for informal audiences. As an outgrowth of that, we are participating in a UV Citizen Science project. We will enlist citizens to measure the amount of UV radiation that hits the earth at Baltimore's Inner Harbor, enter the data into a nationwide database, and then participate in ongoing work to measure changes in UV radiation across the country. People are exposed to scientific equipment, scientific methods, and will be able to participate in a nationwide study. They also gain a greater understanding of the implications of changing UV levels as it relates to their everyday lives.

Maryland Science Center makes its resources available to provide opportunities for students to witness events such as a solar eclipse. In August of 1999, a group of students observed a solar eclipse in Europe via a link with Goddard scientists on board a research vessel in the Black Sea. Students came to the Maryland Science Center to learn about the eclipse and participated in two televideo conferences before and during the event to observe and ask questions.

In partnership with the Johnson Space Center, Maryland Science Center has hosted Baltimore City School students for four live downlinks from the International Space Station and the Space Shuttle since 2001. Students have conversations as well as question and answer sessions with the astronauts aboard the station and the shuttle. Prior to the downlinks, students visited the Maryland Science Center to learn about the specific mission and prepare questions for the astronauts. The missions included the delivery of the Destiny component to the International Space Station, and the Hubble Space Telescope servicing mission. After these two missions, the entire shuttle astronaut crew involved in the downlink visited the Maryland Science Center to meet with the students who participated in the conference and the general public. We were the first informal education institution to have this opportunity, and mentored other museums on how to replicate the experience.

With the Space Telescope Science Institute, we were advisors on the making of a short IMAX film entitled "Hubble: Galaxies Across Space and Time." This three-minute film has been shown in over a dozen IMAX theaters nationwide. At the Maryland Science Center, it has had 1,564 screenings for over 110,000 visitors. We have also developed a planetarium show to explain what the Hubble has allowed us to see and how those images have helped to shape the way we view the universe as well as increasing our knowledge of our place in the universe.

Through collaboration, the Maryland Science Center participates in other smaller programs funded by NASA as part of a larger grant to another institution. We will create a series of programs and events highlighting the New Horizons mission to Pluto and the Kuiper Belt. We will host a small exhibit, offer a teacher workshop and host a Pluto Family Science Night. Keying on the recent news and popular culture references to Pluto's status as a planet or not, Maryland Science Center will present the latest Pluto information as part of a popular planetarium show "Planet Trek". In conjunction with the Howard Owens Science Center in the Prince George's County, Maryland school system, we are to develop a planetarium program on Pluto and the New Horizons mission for distribution to school planetariums nationwide—currently numbering in excess of 600.

In TerraLink, the earth systems science update center, Maryland Science Center has partnered with NASA and NOAA to provide ongoing support for programming including visual material and scientific expertise. NASA and NOAA scientists periodically visit to work with students as part of our Scientist of the Month program and on special programming days such as Earth Day. Students and visitors have a chance to see science pursuits as both a vocational option and simply as a means to broaden awareness that science, technology, engineering and math is not a narrow cast field of inquiry and exploration. The focus of this program is to provide science and technology careerists as role models for students as well as being able to offer another thread for visitors and students to seek out information about how things like atmospheric phenomena occurs. TerraLink staff and the Science Person of the Month collaborate to present topics and information to the public in understandable terms.

Using NASA and NOAA data and visual imagery, as well as utilizing experts from the agencies in the Science Person of the Month program currently defines the extent of Maryland Science Center collaboration with the agencies named in this inquiry. It should be noted however that prior to the institution's recent expansion and broadening of its core competencies, the programmatic synergies between Maryland Science Center and these agencies was limited by definition of scope and mission.

Currently BodyLink, the Maryland Science Center's health sciences update center, collaborates and partners with other Federal agencies—primarily NIH, through its Science Education Partnership Award program—but does not at this time enjoy a relationship with the agencies named in this inquiry. However, topics like the studies of the effects on the human body of extended durations of time spent living in space are of interest to BodyLink staffers and Maryland Science Center and the opportunities to collaborate and deliver programming similar to that which is already in place in SpaceLink and TerraLink are currently tracking with our institutional collaborative goals.

Beyond the Link areas of our core exhibits and programming, and in partnership with NOAA, Maryland Science Center has embarked on an exciting project entitled Science On a Sphere (SOS). This is an earth visualization system developed by NOAA that projects a wide variety of datasets onto a large sphere to create dynamic global views of the entire earth. Visitors observe hurricane development and prediction, tectonic plate

movement and earthquakes, sea surface temperatures and their effect on global weather conditions, as well as observe global warming models and the potential effect on the earth. Science On a Sphere is now a permanent exhibit at the Maryland Science Center. Having this technology also allows us to compare earth to other planets and NASA data sets have been converted to show the Moon, Mars, Saturn and the Sun on the same sphere. We have, in collaboration with NOAA and NASA, developed Maryland Science Center staff-delivered, visitor-centered, programs as well as produced prerecorded programs that explain the images being observed.

We have also developed traveling exhibits. NIST was instrumental in providing technical information for our Titanic Science exhibit. NIST performed analyses of rivets from the Titanic hull that were found at the wreck site to determine the strength level of the rivets, so our information would be factual. One of the questions surrounding the Titanic disaster was whether or not the steel used to make the rivets was of poor quality—and if that might explain how the "watertight" features failed. By presenting the data and the surrounding conditions, visitors were left to their own conclusions as to how the rivets might have contributed to the Titanic's end.

Although we were not asked to speak directly to our collaboration with other Federal agencies, two examples of Maryland Science Center collaboration with the National Institutes of Health are funding and content expertise for a traveling exhibit titled: The Changing Faces of Women's Health and funding and content expertise for our permanent health sciences update center BodyLink.

With the exception of Science On a Sphere, the evaluation of permanent exhibits has been done by the Maryland Science Center. The accepted practice for informal education institutions, as exemplified by the Association of Science- Technology Centers, (ASTC), has been to include a front-end evaluation as part of any project. This involves determining what the public knows about the subject through focus groups and questionnaires. The project is then judged as to what is feasible to build and install, and through prototyping of exhibit pieces, determining if the public will understand the idea or concept presented by the various exhibit pieces. When the project is complete, a summative evaluation is performed to see if the stated goals of the project have been met. This is done through direct observation and public feedback solicitation, usually by an independent third party. If there are changes to be made with the project, a final, remedial evaluation is made to ensure that the intended knowledge transfer has been made. (Attachment B and Attachment C accompanying this testimony illustrate an example of this evaluation process which we completed as part of our development of our permanent earth science and dinosaur exhibit. The exhibit was produced with funding and content support from NASA).

With educational programs, the process is similar. Educators are solicited for areas where an informal experience can add to the students' understanding of the subject matter. When the programs are developed and delivered, feedback is given directly by the educators who bring their students to the center for the educational enrichment. These accepted evaluation procedures are required for National Science Foundation or National

Institutes of Health grants and have been used by science museums for other Federally-sponsored exhibits and programs.

Using the accepted evaluation practices mentioned above, NOAA, NASA and the Science On a Sphere users group (made up of all centers with a sphere installed as well as those centers where spheres are being installed), have embarked on specific evaluation methods for the exhibit as well as the programs centered around the exhibit. Each funded NOAA project contains a detailed evaluation plan. NOAA asked the Maryland Science Center to lead a discussion of all SOS users on the different SOS evaluation methods used to date and what method of prototyping and evaluation will best help science museums develop understandable exhibits and programs for the target school group audiences and the general public.

Using front end evaluation (a copy of the full evaluation can be found in Attachment A which accompanies this testimony) of the Science On a Sphere exhibit—again conducted by third party evaluators—Maryland Science Center was able to implement and utilize the SOS exhibit in response to the feedback collected during the evaluation process. In our case, we developed specific staff-led programs to augment the SOS experience for our visitors. Overwhelmingly, the display of the information and data, the quality of the presentation, overall appeal of the technology, and understanding of the purpose of the exhibit was extremely positive. Once operational at Maryland Science Center however, our exhibits team noticed that when the SOS exhibit ran in auto-play mode using "canned" presentations, and no staff members were available to augment the presentation and answer questions about the data being presented, the level of engagement was short in duration. In general, when the SOS exhibit was facilitated by Maryland Science Center staffers, questions were answered, programming could be paused for explanation, and dwell time (time people spend at a specific exhibit) by visitors was very long in duration. When the SOS exhibit ran in auto-play mode—meaning the canned programs, with their taped narrative—the dwell time for visitors was far shorter. Visitors could not fully comprehend the auto-play presentations and moved on to other exhibit areas more quickly. "Canned" programming for SOS, absent a subject expert who could interpret the presentation for the casual enthusiast, was at too high a level. Programmers may have assumed too high a level of understanding on the part of the museum-goer and the exhibit was losing audience as the visitor became confused or could not fully understand the presentation.

In response to this, Maryland Science Center exhibit team members installed interactive computer kiosks around the SOS exhibit that offered a more basic interpretation of the imagery and programming being presented when the exhibit is in auto-play mode. Visitors can glean basic understanding of the programming's more technical aspects by viewing a more basic interpretation on the interactive kiosk screen. Given this more basic knowledge, the visitor is given the tools necessary to gain a deeper understanding of the original intent of the more specialized canned programming. Program staff have also inserted more facilitated programs into the presentation schedule to engage more visitors more often using the SOS exhibit. To evaluate and measure the success of the remedial actions the exhibit team completed a dwell time study of visitor interaction with

the SOS exhibit prior to the installation of the interactive kiosks to create benchmark dwell time statistics. Now that the kiosks are in place, the dwell time study will be repeated and the data will be compared to the benchmarks created prior to the kiosk's arrival. All the information gathered, the remedial actions employed, and the measures of success are being shared and reported to the NASA/NOAA led SOS users group so that the exhibit is as successful as possible at all locations around the country. As the installation of SOS exhibits began their roll out, greater collaboration between program creators and informal educators earlier on could have led to programs that did not need as much remedial modifications and augmentation. Partnering in the development stage may have gained SOS more audience and enthusiasm more quickly and in greater numbers.

The case with SOS illustrates an example of how to improve scientific literacy. To improve the effectiveness of using informal education to help raise the level of scientific literacy in the United States, emphasis should be placed upon how non-classified information could be made available to the general public. Informal educators such as ASTC members have the ability to dispense highly technical knowledge in a manner that the non-scientific public can understand. In the case of the Maryland Science Center, we employ a cadre of on-the-floor explainers, many of whom have received training from the various Federal R&D mission agencies to augment their own formal education. For every hour that we are open, we have staff members ready to engage our visitors to answer questions or offer ideas that stimulate meaningful discussions about the subject areas. Our goal is to make gaining this knowledge engaging and fun, while showing how science and technology affect our daily lives. In the process, our hope is that we will excite and encourage some of our student visitors to consider careers in science and technology.

In the example provided about the installation, evaluation, and ongoing collaboration with the Science On a Sphere exhibit there is a working example of how Federal agencies and science centers can better accomplish the goals of STEM education programs. We would encourage Federal agencies to continue to expand ways that researchers and engineers collaborate with informal science education professionals to better engage the public. With SOS, scientists were made available to us, evaluation was encouraged, and NASA and NOAA sought our help in getting the message out. There was recognition that science centers, through their use of informal education, know how to engage visitors and spark their interest in the sciences. We know how visitors react and how best to present scientific discovery and scientific progress. And we know how to present it in ways that matter to them as individuals.

The dialogue with science centers should be expanded—we want access to the knowledge and the discovery so we can distill, interpret and present it to the general public and school children in larger and more meaningful ways. We want to reach greater numbers of people more often so that scientific discovery becomes as much a part of a person's everyday life as it can be. We believe that greater understanding leads to greater acceptance that science is resident in everything we do—it doesn't just happen in a laboratory. Science centers like the Maryland Science Center are a resource in every

sense of the word and deserve to be viewed as such—from resources (financial and otherwise) to expertise and knowledge. We believe greater utilization of science centers as resources for Federal R&D mission agencies is the best way help raise the level of scientific literacy with the general public, including school children.