

Extravehicular Activity Systems Education and Public Outreach in Support of NASA's STEM Initiatives in Fiscal Year 2011

Heather L. Paul¹

Mallory A. Jennings²

Erika Guillory Lamberth³

NASA Johnson Space Center, Houston, Texas 77058

NASA's goals to send humans beyond low Earth orbit will involve the need for a strong engineering workforce. Research indicates that student interest in science, technology, engineering, and math (STEM) areas is on the decline. According to the Department of Education, the United States President has mandated that 100,000 educators be trained in STEM over the next decade to reduce this trend. NASA has aligned its Education and Public Outreach (EPO) initiatives to include emphasis in promoting STEM. The Extravehicular Activity (EVA) Systems Project Office at the NASA Johnson Space Center actively supports this NASA initiative by providing subject matter experts and hands-on, interactive presentations to educate students, educators, and the general public about the design challenges encountered as NASA develops EVA hardware for exploration missions. This paper summarizes the EVA Systems EPO efforts and metrics from fiscal year 2011.

INTRODUCTION

The Extravehicular Activity (EVA) Systems Project Office at the NASA Johnson Space Center (JSC) is dedicated to the development of next generation EVA technologies for future exploration. Fiscal year 2011 (FY11) marked the second year in which education and public outreach (EPO) was an official position within this office. This paper summarizes the EVA Systems EPO efforts and metrics from FY11.

FY11 EVA SYSTEMS EPO OBJECTIVES

The FY11 objectives for EVA Systems EPO were the same as in FY10: "to support hands-on, interactive, educational experiences so that students of all ages and levels may learn about the design and operational challenges associated with EVA technologies developed in support of NASA exploration initiatives" [1]. Based on lessons learned from FY10, additional objectives were set as follows:

- The EPO coordination process was updated to: increase communication between requestors, coordinators, and volunteers; make coordination of volunteers, hardware, and facilities more efficient; and to make it easier for volunteers to support events.
- Communication was increased between the EVA Systems EPO team and the Public Affairs Office (PAO) and Office of Education to ensure that volunteer support and events were compliant with NASA education and public outreach requirements.

¹ EVA Systems Education and Public Outreach Lead, Space Suit and Crew Survival Systems Branch, 2101 NASA Parkway, Houston, Texas 77058.

² EVA Systems Education and Public Outreach Volunteer, Space Suit and Crew Survival Systems Branch, 2101 NASA Parkway, Houston, Texas 77058.

³ EVA Systems Education and Public Support Contractor, Tessada and Associates Inc., 2101 NASA Parkway, Houston, Texas 77058.

- An interactive presentation was developed with speaker notes so that volunteers could communicate a consistent message on EVA technology developments and reinforce the concepts of the scientific method, teamwork, and critical thinking.
- A hands-on, interactive, educational activity relevant to current Portable Life Support System (PLSS) packaging efforts was developed to further communicate technical challenges that are under way with NASA's space suit life support development activities.
- Metrics tracking was updated to ensure that event location and audience demographics were provided for all events. (In previous years these metrics were only tabulated for live presentations and demonstrations.)

DEFINITIONS: EPO EVENT TYPES, COLLECTING METRICS FOR EACH EVENT, AND EPO AUDIENCE

EPO Event Types

An EVA Systems EPO event is classified as one of the following types: EVA Systems presentation, Interview, Mentoring, Subject Matter Expert (SME) consultation, or Integrated Tests/Analog. "EVA Systems presentation" represents all presentations delivered by volunteers wherein content is focused on EVA systems topics including spacesuits and crew survival systems. "Interviews" include events that involve an interview by a media entity. "Mentoring" includes events in which a volunteer works with student and/or educator teams on projects via JSC-sponsored and external EPO programs. "SME consultation" includes delivery of career presentations and technical reviews of EVA-related information as requested by PAO and Education. "Integrated Tests/Analog" includes EVA Systems EPO support during tests and NASA analog missions such as Desert Research and Technology Studies (Desert RATS).

Collecting Metrics for Each Event

An EPO request may encompass multiple "events." Metrics are collected for each independent event. For example, EVA Systems EPO volunteers supported the activity *Destination Station: Denver*. Over the three-day period, volunteers conducted twelve presentations at various schools and venues with audiences ranging from elementary school students to adults. Each presentation was counted as one event, resulting in twelve total events.

EPO Audience

The EPO audience is comprised of students, educators, and the general public. For metrics collection, students are divided by grade as follows: kindergarten (K) through 5, middle school, high school, and college.

COLLABORATIVE PARTNERS

In FY11, EVA Systems EPO continued collaboration with the Office of Education and the Public Affairs Office at Johnson Space Center, as well as with the Enabling Technology Development and Demonstration project. Additionally, EVA Systems EPO worked with the NASA Extreme Environments Mission Operations (NEEMO) 15 engineering runs and the Desert RATS analog mission.

FISCAL YEAR 2011 EPO SUMMARY AND METRICS

In FY11, EVA Systems EPO completed a total of 253 events. The majority of these events (166) were live, interactive presentations covering EVA and/or space suit topics presented in classrooms, auditoriums, public events, or via the web. Fifteen media interviews took place throughout the year, resulting in multiple articles and features covering EVA topics and personnel. Ten mentoring opportunities were supported including mentoring student teams for the Texas Aerospace Scholars Programs [2], working with a graduate student in Australia to prepare a technical paper and presentation related to EVA gloves for the International Astronautical Congress, and mentoring a graduate student from the Massachusetts Institute of Technology. Subject matter experts participated in a variety of career presentations to educate the EPO audience about STEM and working for NASA, resulting in fifty one events. Additionally, the EVA systems EPO team supported the NEEMO 15 engineering tests and the Desert RATS analog mission, resulting in eleven events supported². Figure 1 shows the breakdown of the events by type for each quarter of the fiscal year.

² Detailed EPO metrics for the NEEMO 15 engineering runs and Desert RATS analog missions are not provided in this paper.

Event Type	Q1 Events	Q2 Events	Q3 Events	Q4 Events	Total Events By Type
EVA Systems Presentation	31	20	67	48	166
Interview	2	-	3	10	15
Mentoring	-	-	5	5	10
Subject Matter Expert	3	1	8	39	51
Tests/Analog	-	-	2	9	11
Total	36	21	85	111	253

Figure 1. Summary of EVA Systems EPO Events for FY11

Similar metrics were collected in FY09 and FY10. In FY10 a total of 158 events were completed, and in FY09 a total of 72 events were completed. Therefore, FY11 event totals were 1.6 times that of FY10 and 3.5 times that of FY09!

Figure 2 shows the number of EVA Systems EPO Events for each month of the fiscal year. Figures 1 and 2 show that events increased and remained high for the second half of the year. This trend is comparable to that experienced in previous years of supporting EPO events (Figure 3), as these months include a higher incidence of requests to support events related to end of school year activities, on-site NASA programs and facility tours that occur in the summer (such as Texas Aerospace Scholars), and off-site summer camps and schools.

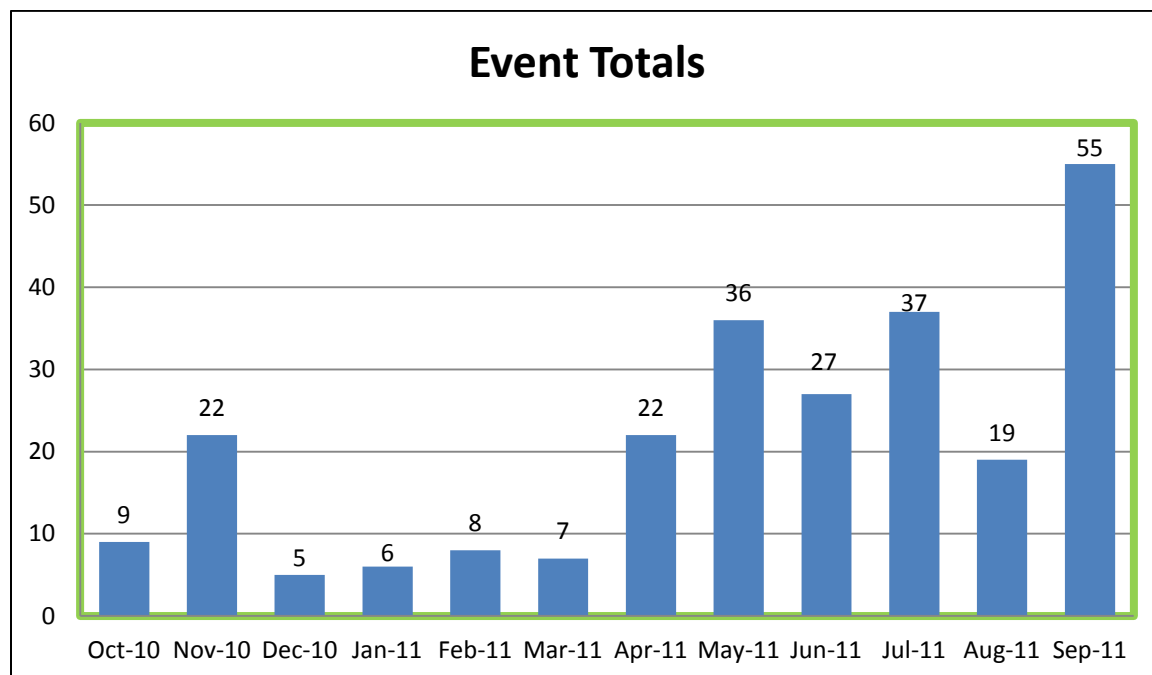


Figure 2. EVA Systems EPO Events per Month for FY11

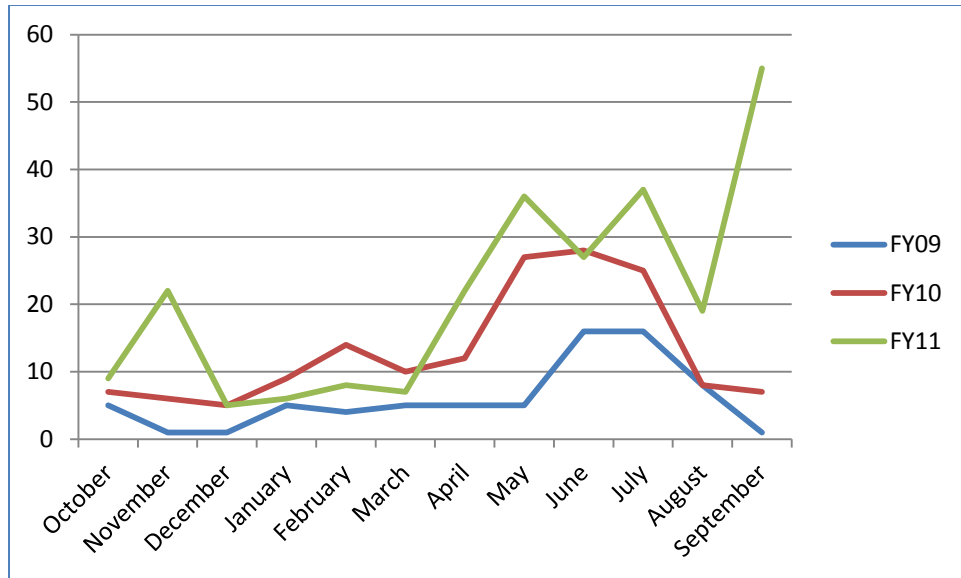


Figure 3. Comparison of EVA Systems EPO Events per Month FY09, FY10, and FY11

METRICS BY LOCATION

The location of an EPO event typically dictates whether it falls under the purview of the JSC Education Office or the Public Affairs Office. If the event is at or within 50 miles of JSC, it is typically managed by the JSC Education Office. If the event is beyond 50 miles of JSC, it is typically managed by the Public Affairs Office, specifically the JSC Speaker's Bureau. Tracking events by location not only ensures that EVA Systems EPO collaborates with the proper NASA offices; it also provides insight into what geographical areas we are reaching with our activities.

Figure 4 shows the summary of EVA Systems EPO events by location. The majority of presentations (159) occurred at or within 50 miles of JSC. Twenty-three events were supported outside of Houston, but within Texas, seventy-one events were beyond Texas but within the United States. No international events were supported this year.

Providing a direct comparison to FY09 and FY10 event locations is not possible, as in past years this metric was only collected for presentations and live demonstrations, whereas in FY11 location details were collected for all events. Comparing trends to previous years, the majority of events still occurred at or within 50 miles of JSC.

Location	Q1 Events	Q2 Events	Q3 Events	Q4 Events	Total Events By Location
B7/B34	5	2	9	7	23
Within 50 Miles of JSC	21	14	50	51	136
Exceeding 50 Miles of JSC, but in TX	3	3	9	8	23
Exceeding TX, but in US	7	2	17	45	71
International	-	-	-	-	-
Total	36	21	85	111	253

Figure 4. Summary of EVA Systems EPO Events by Location

METRICS BY AUDIENCE TYPE

Tracking the EPO audience demographics is important to identify what groups we are reaching with our events. Figure 5 provides a summary of the audience participants for each quarter of FY11. Definitions for each audience group are as follows:

- K-5 consists of students in grades kindergarten through five and associated educators. If parents are attending the event, the number of parents are also included in the K-5 audience numbers.
- Middle school consists of students in grades six through eight and associated educators. If parents are attending the event, the number of parents are also included in the middle school audience numbers.
- High School consists of students in grades nine through twelve and associated educators. If parents are attending the event, the number of parents are also included in the high school audience numbers.
- College consists of university students and associated educators.
- Educators consists specifically of teachers. These events are usually part of a NASA sponsored workshop.
- General Public consists of participants at large events such as conferences and festivals. Typically these audiences are a combination of students and adults, and specific details on ages/grades is not available.

The total audience reached in FY11 was 51,837. An absolute comparison to audience metrics in FY09 and FY10 is not possible as during these fiscal years demographic details were only collected for presentations and live demonstrations, not all events. However, looking at the numbers that we have, FY11 audience participation was significantly greater than in past years. There was a 221% increase over that of the 23,387 total participants in FY10, and a 574% increase from the 9,027 total participants in FY09.

Figure 6 shows audience comparisons for FY09, FY10, and FY11. The greater audience values can be attributed to the fact that we supported more events in FY11, and several of these events were largely-attended. The grossly increased numbers in Q4 are primarily attributed to the large audiences involved with the STS-134 and STS-135 launch activities, during which our team conducted a Digital Learning Network Launchcast and general media interviews with an estimated 11,000 total participants. STS-134 and STS-135 combined audience totals reached 12,919 participants.

Audience Type	Q1 Events	Q2 Events	Q3 Events	Q4 Events	FY11 Total Audience
K-5	625	1,133	1,597	2,536	5,891
Middle School	2,584	1,132	1,377	4,175	9,268
High School	323	1,265	1,207	664	3459
College	185	130	139	81	535
Educators	-	80	80	192	352
General Public	3,739	1,062	2,616	24,915	32,332
Total	7,456	4,802	7,016	32,563	51,837

Figure 5. Summary of EVA Systems EPO Events by Audience Type for FY11

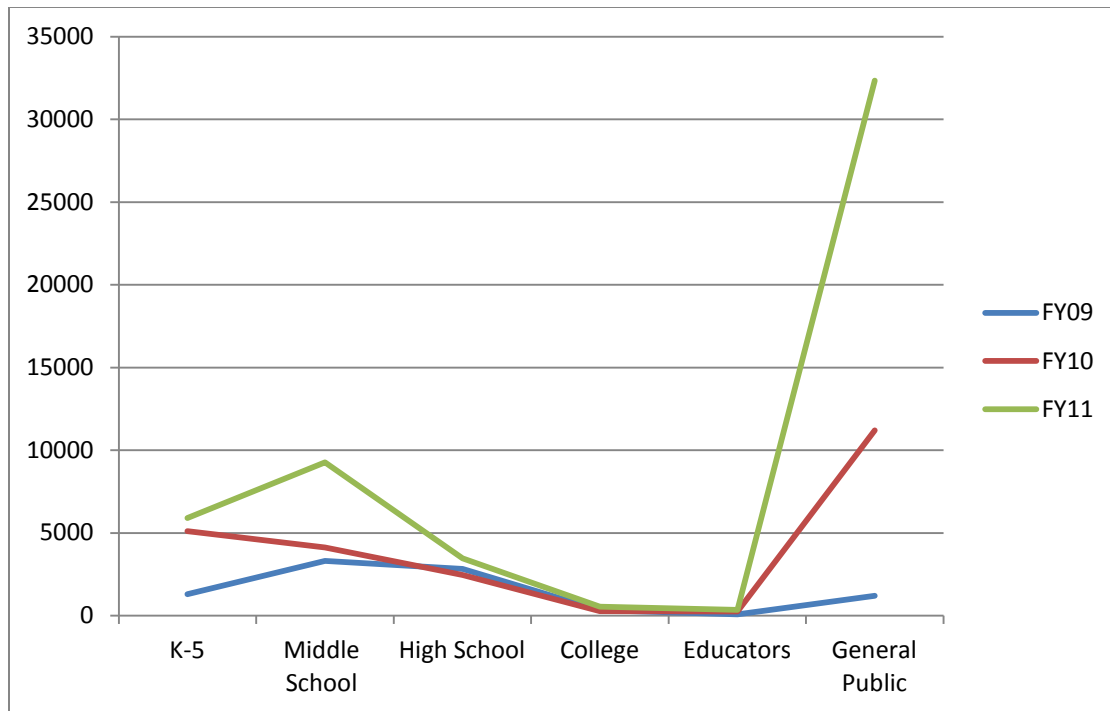


Figure 6. Comparison of Audience Types for FY09, FY10, and FY11

FEATURED FY11 EPO ACCOMPLISHMENTS

EVA Systems Educational Presentation

In FY11, the EPO team introduced a new EVA Systems presentation entitled, “Houston: We Are Go For Exploration!” The presentation emphasizes the correlation between engineering design and the scientific method. It highlights spacesuit history, current design efforts and future design concepts. The new presentation includes speaker notes, recommended teaching moments, and references; and the presentation is export controlled. It can be given to educators as a teaching resource and can be adapted to specific audiences based on grade level. This presentation also aligns with the National and Texas science and math curriculum standard “Scientific Investigation and Reasoning” [3]. Figure 7 shows the cover page of the presentation.



Figure 7. Cover slide for EVA Systems EPO Presentation.

Packing the PLSS Educational Activity

In the second quarter of FY11, the EPO team created the first educational activity about the Portable Life Support System (PLSS). The activity entitled “Packing the PLSS” demonstrates the design process for packaging a PLSS, the importance of component placement in the PLSS for center of gravity optimization, and the test process. Students are placed in roles similar to NASA test teams and must determine the best way to place critical life support pieces, such as oxygen tanks and carbon dioxide scrubbers, into a backpack. The new activity is formatted as a science experiment, and includes a general PLSS overview, a glossary of terms, a list of easy to obtain materials, and a detailed test procedure. The activity can be completed in a minimum of forty-five minutes, and provides options for learning extensions. The activity was beta-tested in the summer of 2010 with middle school educators participating in the Middle School Aerospace Scholars (MAS) program (Figure 8). Figure 9 shows the cover page of the activity.



Figure 8. NASA Middle School Aerospace Scholar Educators Work in Teams to Complete the Packing the PLSS Activity



Figure 9. Cover Page for the Packing the PLSS Educational Activity

FEATURED FY11 EPO EVENTS

STS-134 and STS-135 Launch Activities and End of Shuttle Program Events

There were many activities associated with the final two Space Shuttle missions and the end of the Space Shuttle Program. For STS-134, EVA Systems EPO was requested to support pre-launch activities at the Kennedy Space Center (KSC) Press Site and in the local Orlando area. Display items included the Advanced Crew Escape Suit (ACES), the suit worn during Shuttle launch and re-entry, and the Extravehicular Mobility Unit (EMU), the suit worn during spacewalks. Volunteers supported media interviews and presentations, manned displays at multiple events, and presented at the STS-134 Tweetup. With the success of EVA Systems EPO support of STS-134, EVA Systems EPO was again requested to return for the final Space Shuttle launch activities for STS-135. Support was similar to the STS-134 launch activities, with the addition of post-launch presentations at the KSC Visitor Complex. Over the course of these mission events, EVA Systems EPO supported 16 events with 12,919 audience interactions. Figures 10, 11, 12, and 13 are from the STS-134 and STS-135 events.



Figure 10. A Digital Learning Network (DLN) broadcast with NASA Engineers Heather Paul and Mallory Jennings prior to the launch of STS 135.



Figure 11. NASA Administrator Charles Bolden with JSC Engineers Heather Paul and Mallory Jennings.

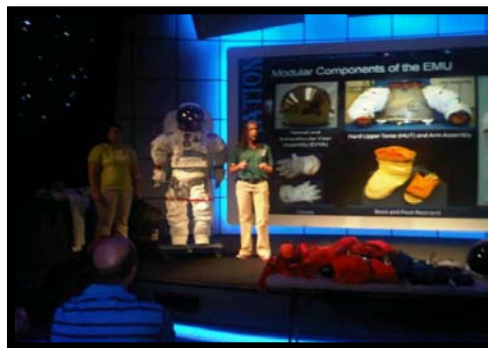


Figure 12. NASA Engineers Heather Paul and Mallory Jennings shared with audiences at Exploration Space at the Kennedy Space Center Visitor Complex after the launch of STS-135.



Figure13. NASA Engineer Heather Paul is interviewed by Levar Burton during pre-launch activities for STS-134.

As the Space Shuttle Program came to a close, EVA Systems EPO was requested to support four events to celebrate the success of the program and the people who supported it. Displays included suit hardware (ACES and EMU) and EVA tools. Over the course of the four events, EVA systems EPO interacted with 9,184 people. Figure 14, from the October 2011 issue of the JSC Roundup [4], includes details on one of the End of Shuttle Program events with a picture of the EVA Systems EPO display (top right) housed in the JSC Building 9 Vehicle Mockup Facility.



Figure 14. EVA Systems EPO support of the *End of Shuttle Program* events featured in a JSC Roundup article

Driven to Explore

The JSC Public Affairs Office within JSC External Relations requested EVA Systems EPO volunteers to support the traveling Driven to Explore display [5]. This multi-media exhibit is set up in areas around the United States that may not have much opportunity for NASA exposure. Volunteers travel to the exhibit location to man the display and represent NASA and the space program. In FY11, EVA Systems EPO volunteers supported Driven to Explore locations in Georgia and Kansas. In total, four volunteers supported 15 events and reached 5,321 participants, approximately 10% of the audience for FY11. Figures 15 and 16 show the Driven to Explore display.



Figure 15. The outside of the Driven to Explore Display at a stop in Kansas.



Figure 16. Inside the *Driven to Explore* trailer and exhibit, where guests can see and touch a moon rock.

Destination: Station - Denver

Destination: Station is a new program developed by the International Space Station (ISS) Office with Education and Public Affairs [6]. The program involves sending an interactive display of a partial, full-scale ISS mockup containing information about the ISS and microgravity research to museums around the United States for six to eight weeks at a time. To kick off the activities, NASA personnel travel to the destination city and conduct presentations at local schools and universities to educate the community about the ISS. EVA Systems EPO was invited to participate in the second Destination: Station event, located in Denver, Colorado. Over three days, two EVA Systems engineers supported seven school visits and five general public events at locales such as the butterfly museum, planetarium, and botanical gardens. During the twelve events, our volunteers interacted with 3,995 people both in person and via webcast. Figure 17 shows the Destination Station exhibit and Figure 18 shows the EVA Systems volunteers interacting with the public during presentations at the Fiske Planetarium.



Figure 17. Destination Station exhibit



Figure 18. NASA Engineers Heather Paul and Mallory Jennings spend time with guests visiting the Destination Station exhibit in Colorado

International Space School

In FY11, EVA Systems EPO representatives presented to 18 international student groups, resulting in 657 student interactions. The presentations were part of the International Space School program sponsored and facilitated by Space Center Houston, an interactive museum in Houston, Texas that brings information about the space program to communities around the globe via standard and tailored educational events. In FY11, EVA Systems EPO partnered with the International Space School program to share with students representing Taiwan, Australia, India, Columbia and Pakistan. Figures 19 and 20 show a volunteer with a group of students from the Taiwan Space School and the India Space School.



Figure 19. EPO representative Erika Lamberth with Taiwan Space School students



Figure 20. Inspiring students with the India Space School

Visits to Texas Children's Hospital and Shriners Hospital for Children

Since FY09, EVA Systems EPO has partnered with the JSC Integrated Projects Office in External Affairs and the JSC Center Director's Office to visit patients at the Texas Children's Hospital located in the Houston medical center. The visits are part of an initiative started by JSC Center Director Mike Coats. As a former Astronaut, Coats has always had a heart for reaching out to children. The goal of the visit is to share the excitement of space with children struggling with serious illnesses.

Each year EVA Systems EPO brings space suit hardware to share with patients and their families. Volunteers answer questions about spacesuits and living and working in space. The children work with volunteers to create their very own *Flat Astronaut*. This art activity allows students to create an astronaut they can take with them after

the visit. Children also have the opportunity to have their picture taken behind a NASA photo board giving them the opportunity to envision themselves as space explorers.

In FY11, EVA Systems EPO spearheaded the first ever visit to Shriners Burn Hospital for Children in Galveston, Texas, partnering once again with the JSC Integrated Projects Office in External Affairs. This hospital specializes in the treatment of severely burned children, and is the hub for Central and South American burn patients needing help. The success of this visit resulted in plans to add Shriners Hospital to our list of annual hospital visits.

JSC Open House

Each year JSC opens its doors to the public for one day as part of the JSC Open House in conjunction with the RE/MAX Ballunar Liftoff Festival [7]. The EVA Systems display, located in the Saturn V building next to the full-scale Saturn V mockup, included the ACES, the EMU, an advanced suit mockup, EVA tools, and several posters and displays showing pictures of our technologies and engineers at work. Eleven volunteers manned the display throughout the day, talking to students and adults of all ages about EVA technology, and what NASA is designing for future exploration. A total of 700 general public participants were tallied for the day, equating to approximately 18% of the total general public audience reached in the first quarter of FY11. Figures 21 and 22 provide pictures from the event.



Figure 21. Visitors interact with engineers at the EVA Systems EPO display



Figure 22. Visitors were allowed to try on space suit gloves

Bring Our Children to Work Day

Bring our Children to Work Day is an annual one-day event during which employees are encouraged to bring their children to JSC to learn more about the work their parents do for the space program. In FY11, EVA Systems EPO supported the event by sharing information about the spacesuit and engineering design with a display in our lobby and a special presentation. An estimated 300 parents and their children were audience members during the events.



Figure 25. Students try on spacesuit gloves with NASA Engineer Heather Paul

LESSONS LEARNED

FY11 was a year of great lessons learned for the EVA Systems Education and Public Outreach team:

- The more events are supported, the more events are requested. This is fantastic, as more events means that there is a continued NASA presence in the community, but event coordination and support does take time and effort. Having a team that is dedicated to the coordination of events is essential.
- The processes to coordinate and support events should be revisited periodically to ensure that NASA requirements for event support are met.
- Making it easy for volunteers to support events is important as it results in more participation from the engineering team.
- Metrics collection is an invaluable way to quantify event support and ensure that the outreach efforts are in line with NASA's education and public outreach goals.
- Tracking all events, as opposed to only presentations as in previous years, is critical to generate the full story of what is being presented, where events are happening, and what audiences are being reached throughout the year.
- The enthusiasm of the volunteers makes a huge difference in the success of an event. NASA engineers that are excited about their work are some of the best representatives to engage audiences and bring the NASA story to the public level.
- Having a prepared presentation with speaker notes proved to be invaluable throughout the year, as volunteers did not have to prepare their own presentations for each event.
- Developing educational activities related to EVA topics is a great way to further enhance presentations with hands-on activities.

CONCLUSIONS

This paper presents a summary of the EVA Systems EPO events and metrics for fiscal year 2011. Through our EVA Systems EPO initiatives we supported two of NASA's overarching strategies: "inspiring students to be our future scientists, engineers and explorers and educators through interactions with NASA's people, missions, research and facilities" and "expanding partnerships with international, intergovernmental, academic and industrial and entrepreneurial communities" [8]. EVA Systems EPO initiatives also aligned with NASA's Strategic Goal 6 to "share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation, and contribute to a strong national economy" [8]. We approached every outreach opportunity with an expected outcome of inspiring participants in the areas of science, technology, engineering and math. We engaged audience participants by providing hands-on interactive presentations and educational experiences. We expanded partnerships with academia by supporting event requests submitted by academic institutions, presenting at educator workshops, and developing educational materials to enhance educator workshops and supplement classroom STEM curricula.

The metrics indicate that FY11 far exceeded the number of events supported and audience participants compared to 2009 and 2010, indicating that we were able to coordinate more support from our EVA Systems team to reach well beyond that of previous years. EVA Systems EPO support is planned for fiscal year 2012, and early metrics indicate that we will exceed our 2011 metrics with more EPO events and a greater number of audience participants.

ACKNOWLEDGEMENTS

The authors would like to thank Glenn Lutz and Lara Kearney from the JSC EVA Systems Project Office for their continued support of education and public outreach, as well as Raul Blanco and Kimberly Baird in the Crew and Thermal Systems Spacesuit and Crew Survival Systems Branch. In addition, the author would like to thank all of the volunteers who have supported these events and activities!

REFERENCES

1. Paul, Heather L. *Extravehicular Activity Systems Education and Public Outreach in Support of NASA's STEM Initiatives*. AIAA-2011-5176, 41st International Conference on Environmental Systems, Portland, Oregon, July 17-21, 2011.
2. Texas Aerospace Scholars website, <http://tas.aerospacescholars.org>
3. Texas Essential Skills and Knowledge for Science Chapter 112.
<http://ritter.tea.state.tx.us/rules/tac/chapter112/index.html>
4. JSC Roundup, October. pg 12, <http://www.jsc.nasa.gov/roundup/online/2011.html>.
5. NASA's Driven to Explore Exhibit, http://www.nasa.gov/pdf/340889main_DTE_FactSheet_508.pdf.
6. Destination Station, http://www.nasa.gov/mission_pages/station/news/destination_station.html.
7. <http://www.ballunarfestival.com/>
8. 2011 NASA Strategic Plan http://www.nasa.gov/pdf/516579main_NASA2011StrategicPlan.pdf