



INSTITUTE FOR DEFENSE ANALYSES

## **Evaluation of DoD's Participation in the USA Science and Engineering Festival**

James Belanich  
Christian Dobbins  
Franklin L. Moses  
Ruhi Srinivasan  
Melissa A. Cummings  
William A. DeMaio  
Kelly O'Connor  
Emily M. Parrish  
Ana M. Venegas  
Steven Waruhiu

November 2018

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IDA Document D-10339

Log: H 18-000474



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### **About This Publication**

This work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0034-14-D-0001, Project AI-2-4016, “STEM (Science, Technology, Engineering and Mathematics) Program Evaluation,” for the STEM Development Office in the Office of the Assistant Secretary of Defense (Research and Engineering) Research Directorate. The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

### **For More Information**

James Belanich, Project Leader  
jbelanic@ida.org, 703-845-6606

Leonard J. Buckley, Director, Science and Technology Division  
lbuckley@ida.org, 703-578-2800

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# Executive Summary

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## Background

Several organizations within the Department of Defense (DoD) that promote science, technology, engineering, and mathematics (STEM) education participated in the USA Science and Engineering Festival (USASEF) (<https://usasciencefestival.org/>), which was held in Washington, DC, on April 6–8, 2018. This year was the first year where an independent evaluation of DoD’s participation in the event was conducted. This report presents the findings and provides some recommendations for DoD’s participation in future STEM festivals.

## Summary of Findings

- Approximately 42,000 people came through the DoD section of the USASEF over the course of the 3-day event.
- Most attendees (87%) came from Washington, DC, MD, and VA. Only 14% of respondents came from farther than 100 miles away, which suggests that the festival has a regional versus national draw.
- The largest cohort of school aged children attendees were from grades 1–8 (32%), followed by grades 9–12 (23%). Only 6% were currently in college or graduate school. Also, 26% of attendees were parents or guardians of children attendees.
- Approximately half the people who visited the DoD area identified themselves as from a military-connected family.
- The attendees to the DoD area were racially/ethnically diverse, with equal representation by male/female students.
- Attendees expressed a high rate of agreement with statements that they learned interesting STEM information (92%) and found the activities in the DoD area engaging (89%).
- Attendees expressed moderately positive agreement with statements that they learned about DoD STEM jobs (69%) and were more likely to pursue STEM education or careers (64%).

## Recommendations

- **Organize DoD Space**—By creating a map of the DoD area with more detail and descriptions than the festival map and handing the map out to attendees, organizers of the DoD space may facilitate attendees' ability to find DoD booths that are of particular interest. The map could also be used to link booths with similar content. For example, if a child finishes an activity using VR goggles in the Army section, the Army representative might recommend that the child try the VR demonstration by the National Geospatial-Intelligence Agency. The map could also be designed or color coded in such a way to make moving through the DoD area an activity (i.e., get a range of colored stickers from various booths to indicate that you have explored the path of DoD science).
- **Improve Lines**—One criticism that a few attendees aired was the length of lines for some activities. A few techniques may help to reduce frustration with lines. One is to provide distractors (e.g., presenters, informational displays, entertainment) or alternative tasks for those in line to make the passage of time seem faster. Another is to use the time a person is in line to prepare them for the activity. For example, instead of giving people directions when they get to the front of the line, organizers could provide the instructions while they are in line so that when they get to the front they are ready to engage in the activity.
- **Schedule Events**—It appears as though posting of times for talks and events allows people to plan their attendance and may have helped increase the number of people who observed or participated in the activities. Also, announcements about 5 minutes before a stage show seemed to increase the number of attendees. The analysis of attendance over the course of each day indicates that the first and last half hour or so had fewer attendees, so having talks or events during the first and last hours of the day should be avoided.
- **Conduct Future Evaluations**—Data collected for this report can now be used as a baseline for evaluating future events using similar tools and methods. This continued evaluation process would allow DoD to refine the STEM engagement activities or determine if DoD should participate in more or fewer events like the USASEF.

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# 1. Introduction

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Within the Department of Defense (DoD) many organizations promote science, technology, engineering, and mathematics (STEM) education. Several of them participated in the largest STEM event in the country, the USA Science and Engineering Festival (USASEF) (<https://usasciencefestival.org/>), which was held in Washington, DC, on April 6–8, 2018. This year was the first year where an independent evaluation of DoD’s participation in the event was conducted. This report presents the findings and provides some recommendations for DoD’s participation in future STEM festivals.

## A. USA Science and Engineering Festival

The USASEF is held every 2 years at the Walter E. Washington Convention Center in Washington, DC. The first day of the festival (April 6) is called Sneak Peek Friday, open only to organized school trips and families with a military connection. During the weekend (April 7–8) the festival is open to the general public. There is no cost for attending, although attendees were asked to register before arriving at the festival.

The festival is very large, with more than 650 exhibitors from science and engineering organizations participating, providing approximately 3,000 hands-on activities and 50+ stage shows. During the 2018 USASEF over 370,000 people participated in the event (USASEF 2018).<sup>1</sup> The exhibit hall floor space is over 700,000 square feet, of which DoD occupied approximately 32,000 square feet of space that included 16,000 square feet for exhibits and booths.

The DoD has been participating in the USASEF since 2012 and was a sponsor of the 2018 USASEF. The cost of sponsorship at the level that DoD provided was \$250,000. The sponsorship facilitates the participation of DoD Components through discounted booth space and increased visibility. As in previous years, there was a Defense Pavilion area to highlight STEM career possibilities within the Department and to showcase DoD technologies that may inspire students to pursue STEM careers. A full listing of the DoD organizations participating in the festival can be found in Appendix A.

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<sup>1</sup> The total of 370,000 appears to include both attendees and those who were working and volunteering at the event.

## **B. Science Festival Evaluation**

There is very little organized research about evaluation methodology and expected outcomes in terms of evaluating festivals and science engagement activities (Bultitude 2014; Longnecker, Elliot, and Condwe 2014; Rowe and Frewer 2005). Challenges to evaluating science engagement include the time/resources necessary to conduct high-quality data collection and analysis, many science-focused organizations not being familiar with social science methodologies, and organizations tending to focus on marketing how “wonderful” an event was versus an evaluation that provides meaningful feedback (Jensen 2015).

One example of evaluating a science festival was conducted by the University of Cambridge (2015). Its assessment included the number of attendees, feedback from attendees (survey), social media behavior, and geographical scope of visitors. Cambridge used this information to establish baseline values of the reach of the festival. The report also included recommendations for future festivals related to promoting the festival, knowing the audience better to shape programming, and conducting additional levels of evaluation through observational techniques.

There is some initial effort to address the lack of evaluative research on science festivals. The Science Festival Alliance (<https://sciencefestivals.org/>) is a professional association of science and technology festivals that are working to make public science events more meaningful, entertaining, and instructive (Science Festival Alliance 2017). In their evaluations, member organizations use metrics like the number of attendees, ratings by attendees, demographics of attendees, fundraising efforts, and return visitor behavior; this sharing of evaluation methodologies may lead to refined procedures for particular contexts. Bultitude, McDonald, and Custead (2011) indicate that there is an emerging trend for science festivals to conduct evaluations; while many of these are informal and do not share the results, there are also some efforts to conduct independent external evaluations and share those results publicly.

## **C. Purpose**

The DoD participation in the USASEF is directly in support of the DoD STEM Strategic Plan (2012). It addresses three of the five DoD STEM Strategic Plan goals: (1) communicate value of DoD STEM; (2) inspire youth and community engagement; and (4) promote participation of underserved groups. The intent of DoD’s participation was to demonstrate and showcase the impressive advances in STEM work at the DoD labs and centers across the Services and to broaden outreach by engaging students from across a racially/ethnically diverse community and reaching military-connected families and students.

The purpose of this report is to evaluate DoD's participation in the USASEF. This is the first such assessment of DoD's participation in a science festival, and the results will provide baseline measures for comparison with future science festival participation and provide some data-informed lessons learned that may be used to improve DoD's participation in future events. The assessment of the festival participation is an effort to address DoD STEM Strategic Goal 5—enhance STEM initiatives using a systematic approach. Evaluation and assessment will help DoD to understand and quantify the impact of participation and provide lessons learned that may assist with planning for future STEM outreach efforts.



## 2. Evaluation Methodology

The USASEF can be considered an outreach or awareness effort for the DoD STEM participants. The evaluation used strategies for assessing outreach and awareness activities based on the “Report of the Data and Reporting Subgroup of the Department of Defense STEM Executive Board Working Group.”<sup>2</sup> This includes observation (i.e., directly observing the attendees and participates) and interviews/surveys (i.e., asking specific questions of attendees). For the evaluation of the USASEF, we used two systematic observation methods (i.e., photographs of DoD area of the festival and visually tracking attendees through the DoD area) and one form of surveying a sample of attendees (i.e., response cards).

The evaluation was focused only on DoD’s participation, but as the red booths in the left side of the upper plan in Figure 1 show, DoD’s area covered less than 10% of the overall festival floorplan. The festival’s total size and the impact of organizations other than DoD were not factored into the current analyses.

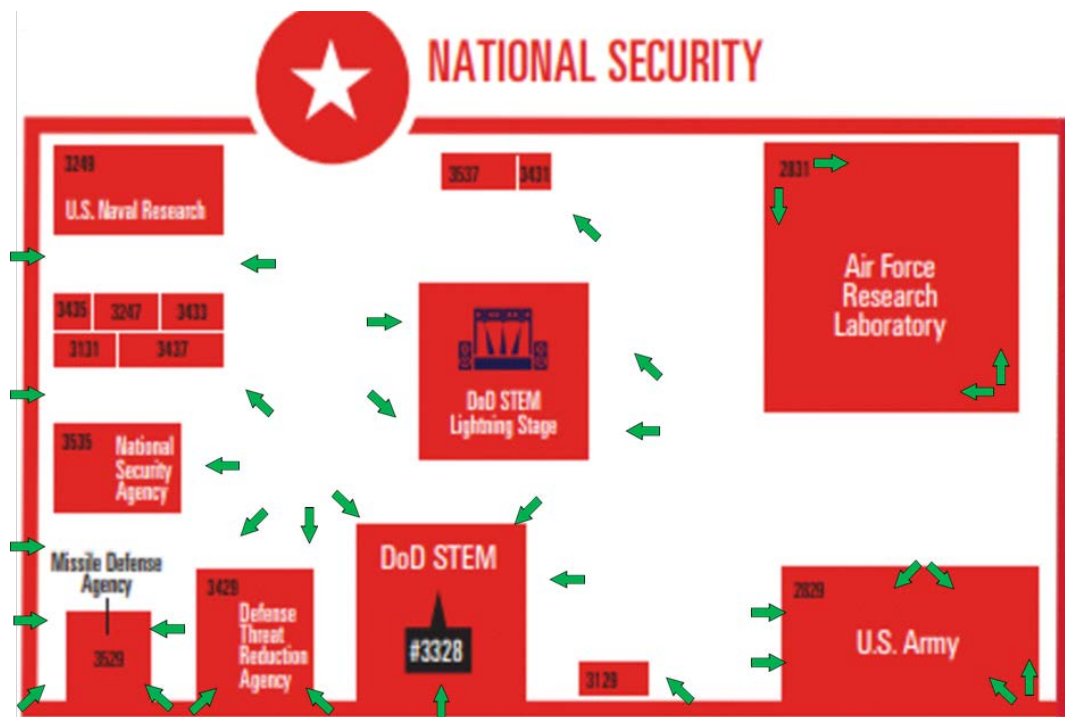


Figure 1. Floorplan of the Entire USASEF, with the DoD (National Security) Area Comprising Only the Red Section Labeled with a Star at the Upper Left of the Floorplan

<sup>2</sup> An unpublished internal DoD report for coordinating STEM evaluation.

## A. Photographic Data

Photographs of attendees at the DoD booths were taken at 30-minute intervals to estimate crowd size. The DoD area was divided into areas that enabled the four photographers to take pictures of the festival in an attempt to capture all individuals in the DoD area at a given time. Figure 2 shows the where the photographers were standing, and the green arrows show in which direction they were pointed as they took the photographs. Appendix A lists the DoD Components and organizations that participated in the festival. The booth numbers that are not labeled with an organization in the figure are listed in Appendix A, a listing of DoD Components and organizations that participated in the festival.



**Figure 2. Physical Layout of the DoD Area, with Green Arrows Representing the Direction in Which Photographs Were Taken**

Because it took about 5 minutes for the photographers to take pictures and walk between photograph locations in their respective sections, there was the possibility that some people would be in multiple pictures. This was corrected for during the counting of individuals from the photographs by looking for people at the edges of sections that might appear in more than one photograph and then only counting them once. The use of photographs to count number of attendees was critical to determining the number of attendees, but could be improved upon in future events if the photographs were taken from an elevated position. A higher perspective may improve the accuracy of counting

individuals in a crowded area, because sometimes it was difficult to determine if there was a shorter person standing behind a taller person in a photograph.

## **B. Tracking Attendees**

A sample of attendees were tracked to determine the time spent in the DoD exhibit area and observe their behavior. For tracking an attendee, the IDA observer would determine a person to be tracked as they entered the DoD area and then unobtrusively observe the attendee's behavior as they moved through the DoD area, until the attendee left the DoD area. The observer would not engage the attendee while they were tracking. The tracking of attendees allowed us to determine how long they were in the DoD area, what booth areas within the DoD section they visited, their level of engagement with DoD personnel/displays, and where they entered/exited the DoD area. A total of 87 people were tracked over the course of the 3 days. Appendix B shows the tracking form.

The observers used the form to record tracked attendees from the time they entered to the time they exited the DoD area and to unobtrusively observe their behavior as they walked through the DoD area. As attendees walked through the area, the observers used codes for interactions (i.e., engage, talk, observe, or pick up program information or swag). The observers used the graphic at the top right of the form to diagram how the attendee walked through the booths. In addition, the observers were free to add additional information (e.g., sat down and rested, seemed really excited, seemed bored waiting in line) or to include comments they may have overheard the attendee make while in the DoD area.

## **C. Response Cards**

A sample of attendees were asked to complete a relatively brief "response card" addressing their demographics, where they traveled from to attend, if they are part of a military family, their level of interest in what they learned, what they liked, their attitude toward STEM, and their likelihood of participating in future DoD STEM programs. There was also a section where they could provide general comments or suggestions. A total of 347 response cards were filled out by attendees over the 3 days of the festival. For some items people could select more than one choice, so for some categories the total number of responses may be greater than 347. The response card is shown in Appendix C.

The evaluators approached individuals in a friendly manner and asked if they were willing to take a few minutes to fill out a response card. If the person responded yes, then the evaluator handed them a card and a pen and waited while the attendee filled out the card. After completing the form, the attendee was thanked and the card collected. Data for multiple measures were collected through the use of the response cards: attendee age group (student in grades 1–8; student in grades 9–12; college or graduate student; parent/guardian of student attendee; teacher/educator; or adult not in one of the other categories), gender, racial/ethnic background, home zip code or city/state, military connection in family,

previous attendance at event, potential future attendance, learned/interest in STEM education and careers, reason for stopping by DoD area, and exhibit preference. In addition, there was a section at the bottom of the card where attendees could write in comments or suggestions.

#### **D. Observations**

Each day there were six evaluators on site, and when they were not actively collecting data they observed the DoD area. In addition to collecting the systematic data described above, they also observed what seemed to be working well or not so well in the DoD area. One example of this was how people were waiting in lines to participate in exhibits. The IDA research team overheard a few festival attendees discuss lines and observed the body language of those in the lines. IDA observed two activity lines (where lines were common) to identify issues and potential solutions to the festival attendee complaints. In addition, the IDA evaluators noted that some DoD exhibits seemed to adapt their processes during the festival in an attempt to improve how the attendees were able to engage with the exhibits.



### 3. Results

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Data on the DoD section of the festival allows us to estimate how many people attended, how long they spent in the DoD section, their demographics, their level of interest, and how far they traveled to attend. Some results, such as movements of attendees around the area, depended on combining data from photographs of the crowds and from tracking some attendees. Comments from attendees and costs of the festival also are summarized. The results provide a set of baseline data or information to help place future festivals into perspective, and they offer some lessons learned that may be used to improve future festival participation.

#### A. Dwell Time

From the tracking data, we were able to determine the length of time that each tracked person spent in the DoD area (i.e., difference in time between when attendees entered and exited the DoD area). As shown in Figure 3, on Sneak Peek Friday, when the festival was open to school trips and military-connected families only, the average time spent in the DoD area was 9.7 minutes. On Saturday and Sunday, when the festival was open to the general public, the average time spent in the DoD area was 18.6 and 17.5 minutes, respectively. Comparing Friday to Saturday and Sunday indicates that the attendees on Friday spent a statistically significant shorter time than those on Saturday/Sunday ( $p = 0.0264$ , two-tailed  $t$ -test).

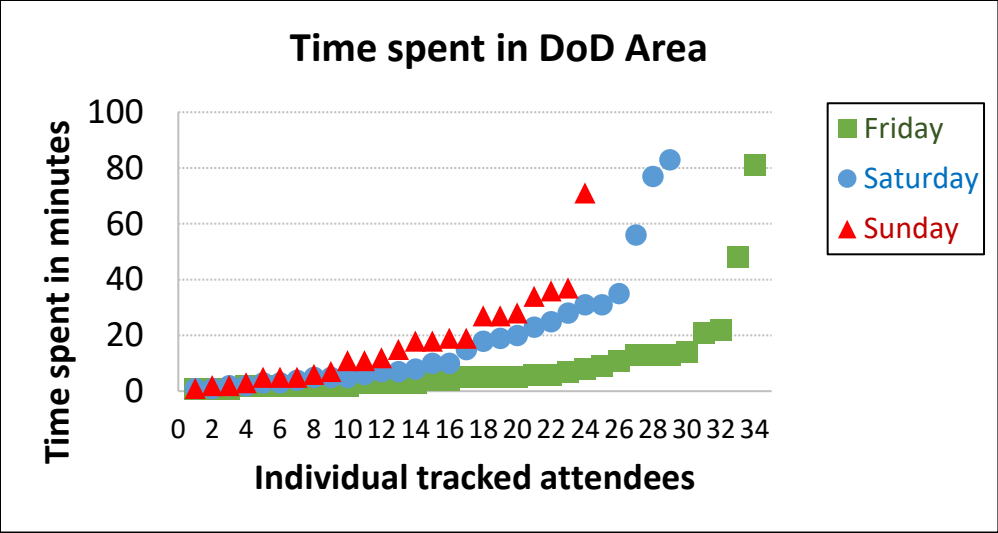


Figure 3. For Each Person Tracked, the Total Time They Spent in the DoD Area. The color coding of green for Friday, blue for Saturday, and red for Sunday will remain consistent throughout the results section.

There was a broad difference in the total time spent in the DoD area across all attendees tracked, with a range of 1 to 83 minutes. By analyzing the average amount of time spent at a booth, we could describe how people spent their time within the DoD section. As shown in Figure 4, there is a positive relationship between the overall time spent in the DoD area with the length of time spent at individual booths. Note, however, that this increasing function seems to asymptote, in that attendees who spent more time in DoD (20–80 minutes) tended to visit more booths and spend an average of about 6–10 minutes per booth.

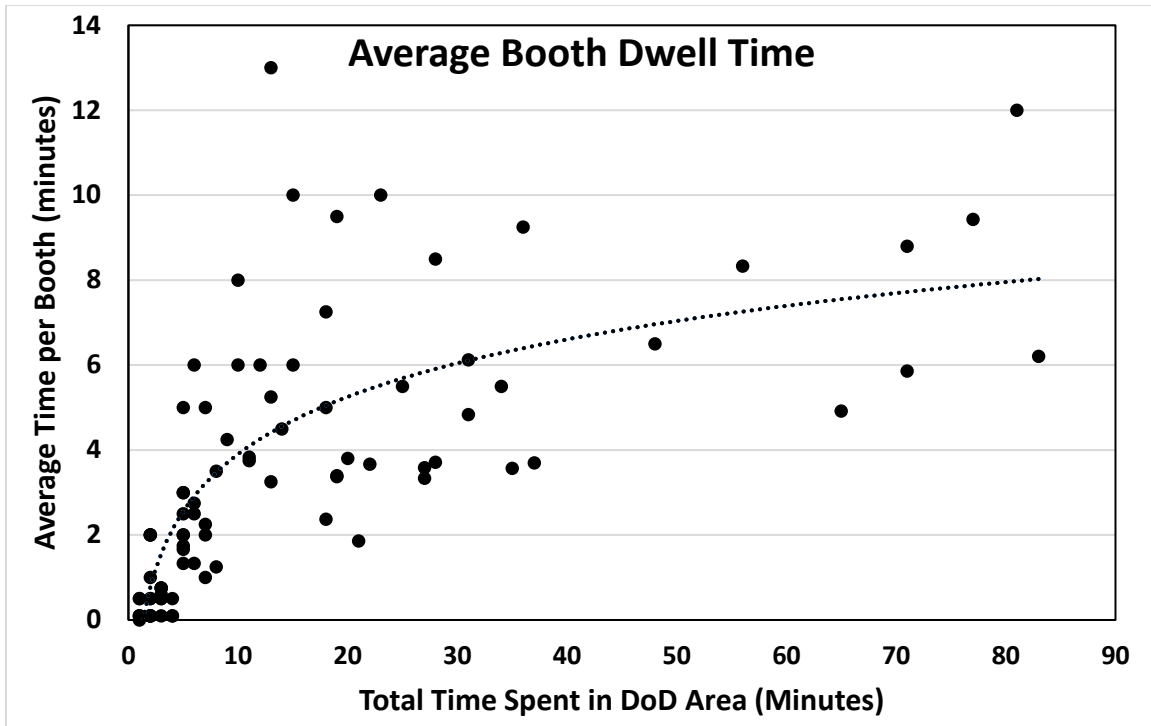
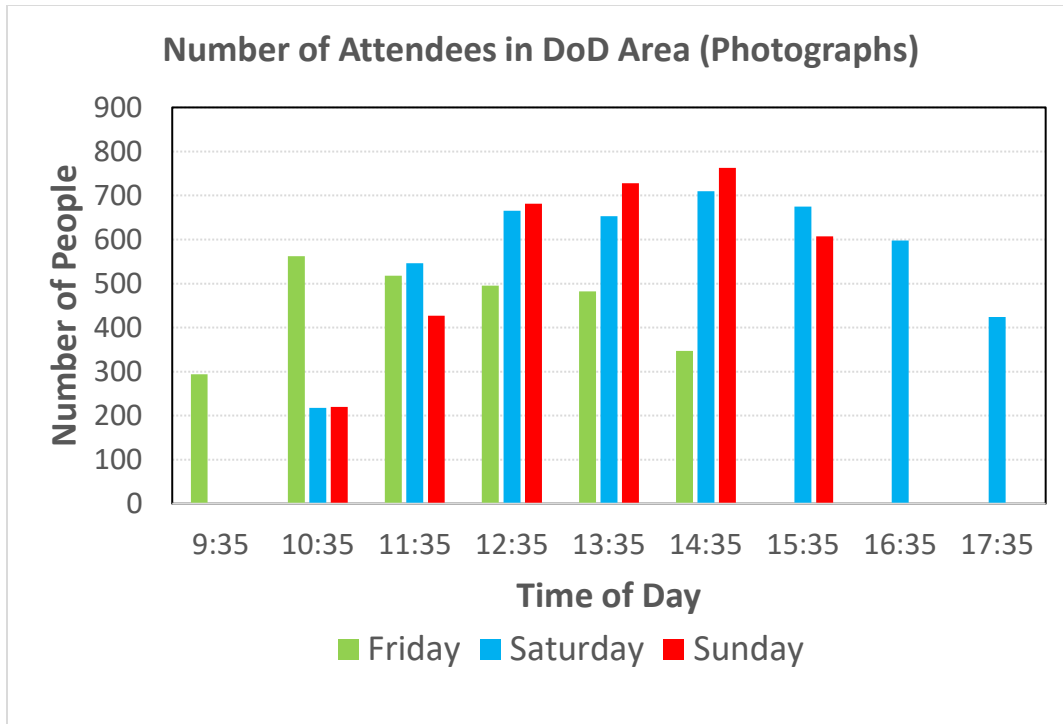


Figure 4. Average Time Spent at Individual Booths Compared with the Overall Amount of Time Spent in the DoD Area. The dotted line is a trend line of average time per booth as total time spent in DoD area increases.

## B. Number of Attendees

Using the photographs, we counted the number of attendees in the DoD section at specific times on all three days of the event. Figure 5 shows the number of individuals counted at each time interval across the three days. Note the consistent pattern across days, where the first and last hours have far fewer people than the middle of the days. The average number of attendees during the first and last hours of the day was only 57%, 45%, and 54% of the peak point for each day on Friday, Saturday, and Sunday, respectively.

Using the number of people at any one time and the average flow rate for a particular day (inverse of dwell time), we estimated the total number of people on each day who came through the DoD section. During the 6 hours on Friday we estimated that 16,458 came through the area; during the 8 hours on Saturday, 14,365; and during the 6 hours on Sunday, 11,648, for a total estimate of 42,471 over the course of the 3 days. As a comparison, according to estimates in the USASEF Recap Report, “many exhibitors reported that roughly 10,000 visitors stopped by their booth over the course of the 3-day Expo, and some said upwards of 70,000 passed through their booth!”



**Figure 5. Number of Attendees Based on the Photographs Taken at Specified Time Intervals**

### C. Demographics of Attendees

We analyzed the demographics of the attendees to the DoD sections of the festival through the response cards where individuals self-identified with particular characteristics.

#### 1. Military-Connected Families

Approximately half the people who visited the DoD section identified themselves as from military-connected families, as shown in Table 1. The results indicate that a majority of the individuals who attended on Friday and went to the DoD section were from military-connected families. This is not surprising given that Sneak Peek Friday was open only to military-connected families and organized school trips. The percentages for Saturday and Sunday are still relatively high at 40% and 47%, respectively.

**Table 1. Number and Percentage of Individuals Who as Members of Military-Connected Families or Not military Connected**

	Responses	Friday	Saturday	Sunday
Military Connected	146	59%	40%	47%
Not Military Connected	163	41%	60%	53%

Using the number of people on each day who came through the DoD section and the percentages of people from military-connected families, we were able to estimate the number of attendees from military-connected families. On Friday we estimate that 9,710 came through the area; on Saturday, 5,746; and on Sunday, 5,475, which sums to 20,931 over the course of the 3 days. The USASEF Recap Report did not give estimates for number of attendees that were connected to the military.

## 2. Age Categories

The primary age group of attendees (who filled out response cards) are school-aged children. As shown in Table 2, the largest age cohort for those who filled out the response cards was children in grades 1–8 (32%), followed by parents/guardians (26%) and students in grades 9–12 (23%).

**Table 2. Number and Percentages of Age Groups for Individuals Who Filled out Response Cards. The missing data were not included in the percentage calculations.**

	Responses	Percentage
Student grades 1–8	130	32%
Student grades 9–12	96	23%
Student in college or graduate school	23	6%
Parent/guardian of student attendee	107	26%
Teacher/educator	22	5%
Adult not in above categories	31	8%
Missing	3	

Relatively similar age breakdowns were observed through the tracking data estimates and the data presented in the USASEF Recap Report, although they used different age categories and did not differentiate across types of adults (e.g., parent, teacher). The USASEF Recap Report indicated that 26% were age 10 and under, 23% were in middle school or junior high school, 12% were in high school, only 2% were age 19–25, and 37% were over the age of 25.

## 3. Race and Ethnicity

No single race/ethnicity was a majority of the representation at the science and engineering festival, as shown by Table 3. The largest representation was for people who self-identified as White (48%), followed by Asian (21%), Black or African American (16%), and then Hispanic or Latino (10%). In addition, 2% identified as Native Hawaiian/Pacific Islander and 2% as American Indian/Alaska Native. Thirty-one respondents (9%) indicated more than one race/ethnicity, and these responses are incorporated into the data below. The overall results indicate a broad representation across race and ethnicities.

**Table 3. Total Number of Responses and Group Percentages for Individuals Who Completed the Racial/Cultural Description Item on the Response Card**

	<b>Responses</b>	<b>Percentage</b>
<b>Hispanic or Latino</b>	39	10%
<b>Asian</b>	79	21%
<b>Native Hawaiian/Pacific Islander</b>	9	2%
<b>American Indian/Alaska Native</b>	8	2%
<b>Black or African American</b>	62	16%
<b>White</b>	182	48%
<b>Missing</b>	8	

Relatively similar distributions across race and ethnicity were observed in the data presented in the USASEF Recap Report, which indicated that attendees were 43% Caucasian, 26% African-American, 22% Asian-American, 9% Hispanic, 0.5% Native American, and 0.5% Pacific Islander. Many of the attendees to the DoD STEM area of the festival were from the Washington, DC, metropolitan area, which includes nearby counties in Virginia and Maryland (as described below in Section 3.E), and the race/ethnic diversity in those areas is similar, with 46% White, 25% Black, 16% Hispanic, 10% Asian, 3% multiracial, and less than 1% for American Indian, Alaskan Native, and Pacific Islander.<sup>3</sup>

#### **4. Gender**

There was a nearly equal percentage of males and females among those who filled out response cards, as shown in Table 4. In addition, one respondent wrote in “other” and checked that as their selection.

**Table 4. Total Number of Responses and Percentages of Gender Responses from the Response Cards**

<b>Gender</b>	<b>Responses</b>	<b>Percentage</b>
<b>Male</b>	158	48%
<b>Female</b>	168	51%
<b>Other</b>	1	0.3%
<b>Missing</b>	29	

This is in agreement with the USASEF Recap Report, which indicated that “the breakdown of male to female attendees was just about exactly 50/50.”

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<sup>3</sup> Data from Data USA: <https://datausa.io/profile/geo/washington-arlington-alexandria-dc-va-md-wv-metro-area/>.

## D. Attendee Perspective

To gauge attendee perspective, level of interest, and potential impact, four Likert-scaled questions were asked on the response cards specifically about the DoD area at the festival. As shown in Table 5, the results were positive, with 92% of respondents saying that they agree or strongly agree with the statement “I learned interesting STEM information”; 89% found the activities in the DoD area engaging; 69% learned about STEM job opportunities at DoD; and 64% stated that they were more likely to pursue STEM education/careers.

**Table 5. The Percentages of Likert Scale Responses for the Interest Items on the Response Cards**

Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Learned interesting STEM info	2%	0%	7%	44%	48%
Found activities in the DoD area engaging	1%	1%	8%	40%	49%
Learned about STEM job opportunities at DoD	2%	6%	22%	37%	32%
More likely to pursue STEM education or career	2%	5%	30%	28%	36%

## E. Distance Traveled

To get an understanding of the geographical reach of the festival, we asked individuals who filled out the response cards to provide their zip code or city/state information. As shown in Table 6, most respondents (74%) traveled 50 miles or less.

**Table 6. The Total Number of Responses and Percentages for the Estimation of Distance Traveled to Attend the Festival**

Distance Traveled	Responses	Percentage	Friday	Saturday	Sunday
Traveled <15 miles	97	31%	33%	34%	25%
Traveled 16–50 miles	133	43%	33%	41%	55%
Traveled 51–100 miles	36	12%	18%	10%	8%
Traveled 101+ miles	45	14%	16%	15%	13%

A few states were well represented, with most of the attendees coming from Washington, DC, and the two closest states (Maryland and Virginia), as shown in Table 7. Some additional states had low levels of attendance, and these tended to be states on the East Coast or relatively close to Washington, DC. From our information from the response cards, there was no representation from states west of the Mississippi River.

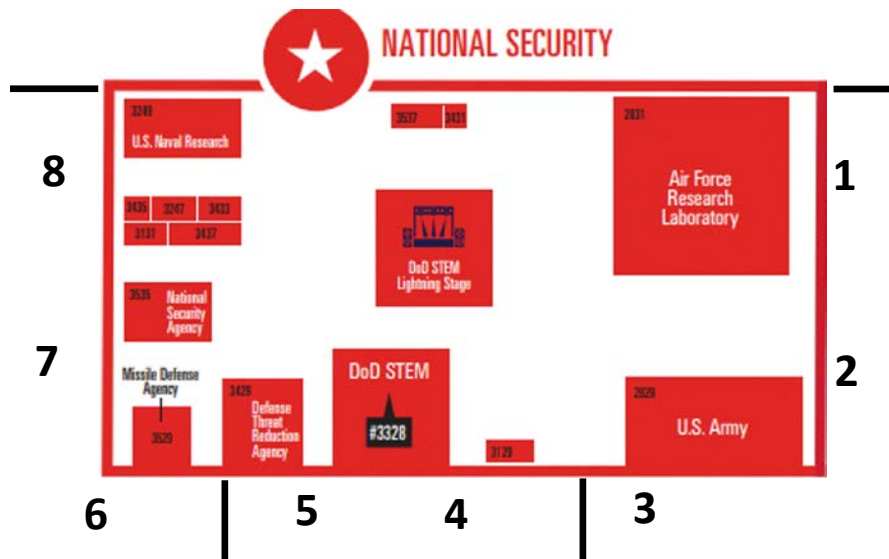
**Table 7. Total Number of Responses and Percentages of the Six Geographic Locations with the Highest Representation. All other states mentioned (GA, NC, NJ, DE, FL, OH, IL, TN, and non-US) had fewer than four responses.**

State Representation	Responses	Percentage
MD	125	38.8%
VA	122	37.9%
DC	33	10.2%
PA	11	3.4%
WV	8	2.5%
NY	6	1.9%

The data from Table 7 show that while the name of the festival (USA Science and Engineering Festival) suggests national coverage, the representation is primarily regional in nature. Our results are similar to the USASEF Recap Report, which states that 93% of attendees came from DE, FL, GA, MD, NC, NJ, NY, PA, SC, VA, Washington, DC, and WV. The USASEF Recap Report also notes that there were attendees from 48 out of 50 states and from 54 other countries, but these could have been a relatively small representation from outside Eastern United States.

### F. Flow In/Out of DoD Area

We assessed the movement of individuals from the tracking data. From this we were able to identify the area where they entered the DoD section and then where they exited. We used a numbering scheme (shown in Figure 6) for subsections of the DoD area to indicate where an attendee came into or left the DoD area.



**Figure 6. The Areas where People Entered or Exited the DoD Section**



Table 8 shows the results of the entry/exit data. The most common (59%) area where people flowed in was from the right (Areas 1, 2, 3); only 16% came in through Areas 4 and 5, and 24% came in through Areas 6, 7, and 8. The most common area (47%) where people exited was Areas 6, 7, and 8; 40% left through Areas 1, 2, and 3, but only 12% left through Areas 4 and 5.

**Table 8. Areas Where Attendees Entered and Exited the DoD Section by Percentage**

		Area where attendees exited			Total in per area
		1,2,3	4,5	6,7,8	
Area where attendees entered	1,2,3	23%	9%	27%	59%
	4,5	6%	1%	9%	16%
	6,7,8	11%	2%	11%	24%
Total out per area		40%	12%	47%	

Note: Totals do not sum to 100% due to rounding.

The positioning of the DoD area may have influenced the flow patterns through it. The main entrance to the convention center was in the direction of DoD areas 1, 2, 3, so it is logical that a majority of people who came to the DoD did so through those areas. The DoD section was near the rear of the overall floorplan, which may have influenced how many people reached the DoD area.

**G. Cost Data**

The ten DoD components who participated provided their aggregated expenses for most of their costs for the festival. The costs varied across components and included the fees associated with the 15,900 square feet of booth space along with associated personnel and miscellaneous expenses, and totaled to \$848,667.36. With the estimated number of attendees in the DoD area being 42,471, this leads to an estimated cost per attendee of \$19.98. We were unable to find a comparison to other science festivals to determine if this cost is high, average, or low. However, DoD can use this estimate as an initial benchmark for evaluating costs for similar activities in the future. Only after collecting data from multiple similar events can a comparison be made to determine the relative value of the effort.

**H. Attendee Comments**

The comment section on the response cards yielded information from the attendees that provides perspective on their experience at the DoD areas. Some of the most common comments on the draw of the DoD area consisted of a particular exhibit or particular educational or professional interest. Exhibits that were mentioned multiple times included

drones/robotics, the isolation chamber, vacuum cannon, infrared display, Enigma, straw rockets, night vision, lightning talks, how to fly a plane, working with light/lasers, opportunities in STEM, corrosion, and computer coding. In addition, exhibits mentioned as enjoyable were described as math problems, battery building exhibit, women in STEM, virtual reality, bugs/neuroscience, 3D printing, electromagnetic waves, and Raspberry Pi. The reasons for why the exhibits were enjoyable included engaging, interactive, it was cool, relates to military (family member in military), potential career interest.

Some attendees mentioned United States Naval Academy (USNA), Air Force Research Laboratory (AFRL), Army/Army Education Outreach Program (AEOP), U.S. Military Academy at West Point, Defense Threat Reduction Agency (DTRA), and National Securing Agency (NSA) as exhibits they enjoyed. This seems to be primarily due to the interactive nature of the exhibits (“hands on,” “engaging,” “active learning”), which appealed especially to the kids attending. Programs that attendees learned about and would like to participate in the future included internships, AEOP, Science, Mathematics & Research for Transformation (SMART), Gains in the Education of Mathematics and Science (GEMS), Air Force STEM, Navy, and NSA scholarship. In addition, general career and STEM opportunities were mentioned as a reason to visit the DoD area. Also, swag (i.e., free promotional items) was mentioned as a reason for spending time in the DoD area, with multiple attendees describing the attraction of the light-up bouncing balls. When asked about favorite exhibits festival-wide (i.e., non-DoD), top answers included National Aeronautics and Space Administration (NASA), DoD, Lockheed Martin, National Institute of Health (NIH), robotics, and food science.

Some of the suggestions for general improvements included reducing line wait times and providing clearer information about when particular events might occur; adding a rest area or a lounge with coffee; and providing a separate person to answer questions about STEM careers.

## **I. Observations**

The observations of the evaluators were not part of the original evaluation plan, but during the course of the 3-day event there were a few aspects of the festival that warrant some discussion: the lines for activities, scheduling of activities, and integrating the different DoD subsections.

### **1. Line Analysis**

During the first 2 days, the IDA research team heard a few comments from festival attendees about the lines for some activities. We developed an ad hoc assessment to observe some activity lines to determine if we could identify issues and potential solutions to the festival attendee comments. This included how many people were in the line, what they

were doing while in line, and how many people flowed through the line and participated in the activity.

- AFRL Drone Line
  - Observed for 24 minutes; 13 people completed the activity.
  - Line extended perpendicularly away from the activity so that people in the back of the line could not view the activity while waiting. It wasn't until they were near the front of the line that they could see the people engaged in the activity. Some people looked bored while waiting in line.
  - Line length averaged 12 people over observation period.
  - The rate of people through the line was 0.5 people per minute.
- Communications-Electronics Research, Development and Engineering Center (CERDEC) Night Vision
  - Observed for 10 minutes; 24 people completed the activity.
  - Line was alongside the exhibit, and people in line had video screens showing relevant information while waiting in line.
  - Line length averaged 10 people over observation period.
  - The rate of people through the line was 2.4 people per minute.

## **2. Scheduling**

A few activities in the DoD area were schedule or time dependent, and it seemed that the process for alerting the attendees when an event was to take place shifted over the course of the 3-day event. For example, during the first day, demonstrations of the Army's vacuum powered gun did not occur at regular intervals. The demonstration itself was popular. The demonstrator would ask a child in the crowd to help as a vacuum was created in a long, clear tube with a ball at one end. Then, the child would break the vacuum seal, which caused the incoming air to quickly propel the ball the length of the tube, where it broke through a seal at the other end and left the tube as a projectile. Attendees seemed to enjoy this demonstration, and the equipment looked interesting enough that several attendees would ask when it was going to be demonstrated again. During the second day of the event, the demonstration times were posted, and Army personnel near the exhibit would tell people that it would be shown in "X" minutes, so if they wanted to look at another Army exhibit and then come back they could see the vacuum gun in action. This seemed to be a good tactic to keep people in the Army area, guiding them to other exhibits while they waited for the vacuum gun demonstration.

### 3. Organization of Space

We made a few observations based on the DoD space at the festival:

- A detailed map of the DoD area might have been helpful to attendees and may have kept them in the DoD area. Such a map could allow DoD personnel to guide attendees to particular exhibits. Several times attendees asked the IDA evaluators where specific DoD exhibits were, and we were usually able to point, describe, or guide them, but having a map might have made it easier. One attendee commented that it would be nice to have a map so they could figure out what to see in the area versus just wandering around.
- Except for the large red star and the booth numbers in red hanging from the ceiling, there wasn't much to link the DoD booths together. There was a large circular banner that had "DoD STEM" on it near the center of the DoD area, above the OSD STEM area. A few children asked "what is DoD" while filling out the response cards, and the range of booths within DoD had to be explained.
- The MDA activity of building a tube missile included cutting out pieces of paper and attaching them to an inflated tube. This was a very popular exhibit, and the line was regularly a few people deep along the length of the booth. Nearby was a festival rest area with tables, and many people took their materials to the tables to put together their tube missile. Having the extra tables seemed like it helped many people complete the activity.

## 4. Conclusions

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This initial evaluation of DoD's participation in the USASEF set a baseline of metrics for DoD STEM programs. Because this was the first such evaluation, there were no prior data for comparison with current results. For future events, the data from this evaluation could be used for comparison. This comparison may be for subsequent USASEF (the next one will be in 2020) or with other festivals or similar outreach efforts in which DoD is a participant.

There is a dearth of academic literature on evaluating the impact of science festivals. One of the complexities of this evaluation was that it focused on the DoD's area, which was part of the larger USASEF. In one way the DoD area could be considered large in that it covered 32,000 square feet (16,000 square feet was the footprint of the booths themselves, with additional open space in between the booths) and had numerous booths from many different DoD organizations and agencies. On the other hand, the DoD area was less than 10% of the overall USASEF. For this evaluation we designed a few data-collection methods that could be used (potentially with some modifications) in future assessments of STEM festivals and STEM outreach programs. If future evaluations are conducted at the USASEF, it would be useful to use the same metrics and methods on a non-DoD organization to help compare, and provide a deeper context to, the results. For example, the same metrics and methods could be used by some or all of the Federal Government agencies that participated in the festival.

### A. Summary of Findings

There were many informative findings from the evaluation, and given that this was the first such evaluation, it establishes a baseline for subsequent festival participation by DoD or other events that can be considered as outreach/awareness activities. A summary of the results includes:

- Approximately 42,000 people came through the DoD section of the USASEF over the course of the 3-day event.
- Most attendees (87%) came from Washington, DC, MD, and VA. Only 14% of respondents came from farther than 100 miles away, which suggests that the festival has a regional versus national draw.
- The largest cohort of school aged children attendees were from grades 1–8 (32%), followed by grades 9–12 (23%). Only 6% were currently in college or

graduate school. Also, 26% of attendees were parents or guardians of children attendees.

- Approximately half the people who visited the DoD area identified themselves as from a military-connected family.
- The attendees represented a range of racial and ethnic diversity, with multiple groups (White, Asian, African American, and Hispanic or Latino) with at least 10% representation each and no single group being over 50%.
- The attendees were equally represented by males and females.
- The Friday (Sneak Peek) session, which was limited to organized school trips and military-connected families, had different characteristics than Saturday and Sunday (open to general public):
  - Shorter dwell time of attendees on Friday.
  - Greater percentage of attendees were military-connected on Friday.
- Attendees expressed a high rate of agreement with statements that they learned interesting STEM information (92%) and found the activities in the DoD area engaging (89%).
- Attendees expressed moderately positive agreement with statements that they learned about DoD STEM jobs (69%) and were more likely to pursue STEM education or careers (64%).
- The overall expense for DoD's participation was at least \$831,896.36, but that may not have included some additional expenses like salaries for DoD personnel or contractors who manned the booths.

To provide the findings described above, this evaluation effort required the development of a few data-collection methods that might be helpful for future DoD evaluations. One example is the response cards, which enabled us to gather information about the demographics of the attendees, what they were interested in, and gauge the level of engagement. If we use similar items to evaluate other STEM outreach/awareness activities, events could be compared. Another method developed for this evaluation was the tracking of attendees. Although the tracking system provided critical information for the evaluation, it could be improved by providing those doing the tracking with a more detailed map and booth descriptions a few weeks before the event. Likewise, the use of photographs to count number of attendees was critical to determining their number, however, if the photographs were taken from an elevated position, the accuracy of the count would be improved in a crowded areas.

## **B. Recommendations**

The evaluation results suggest a few recommendations that may be useful when planning future DoD STEM events. These include:

### **1. Organizing DoD Space**

The DoD space at the festival was relatively large (32,000 square feet is about the area of seven full-sized basketball courts), and many DoD organizations participated, both of which may have made it difficult for some attendees to find particular activities or booths they were looking for. By creating a map of the DoD area with more detail and descriptions than the festival map and handing the map out to attendees, organizers of the DoD space may facilitate attendees' ability to find DoD booths that are of particular interest.

The map could also be used to link booths with similar content. For example, if a child finishes an activity using VR goggles in the Army section, the Army representative might recommend that the child try the VR demonstration by the National Geospatial-Intelligence Agency. The map could also be designed or color coded in such a way to make moving through the DoD area an activity (i.e., get a range of colored stickers from various booths to indicate that you have explored the path of DoD science).

While our crowd-flow analysis was relatively rudimentary, it indicates that in general people were moving from the front door of the convention center (most entered DoD section from the area nearest the front door). It might help to increase flow by having the DoD section closer to the front door or entrance points to the exhibit floor.

### **2. Lines—Making Them More Bearable**

One criticism that a few attendees aired was the length of lines for some activities. A few techniques may help to reduce frustration with lines. One is to provide distractors (e.g., presenters, informational displays, entertainment) or alternative tasks for those in line to make the passage of time seem faster. Another is to use the time a person is in line to prepare them for the activity. For example, instead of giving people directions when they get to the front of the line, organizers could provide the instructions while they are in line so that when they get to the front they are ready to engage in the activity.

### **3. Scheduling Events**

It appears as though posting of times for talks and events allows people to plan their attendance and may have helped increase the number of people who observe or participate in the activities. Also, announcements about 5 minutes before a stage show seemed to increase the number of attendees. The analysis of attendance over the course of each day indicates that the first and last half hour or so had fewer attendees, so having talks or events during the first and last hours of the day should be avoided.

#### **4. Future Evaluation**

For this evaluation we designed a few data-collection methods that might be helpful in the future. These include providing response cards to a sampling of attendees to gain information, tracking attendees and recording their activity to see how they moved through the DoD area, and taking photographs to count number of attendees. In addition, we also developed an ad hoc process for analyzing line movement. This provided us some insight into characteristics of lines and wait times that might be informative. The data collected can now be used as a baseline for evaluating future events using similar tools and methods. This continued evaluation process would allow DoD to refine the STEM engagement activities or determine if DoD should participate in more or fewer events like the USASEF.

#### **C. Conclusion**

The DoD STEM Strategic Plan includes the goals:

1. Communicate value of DoD STEM.
2. Inspire youth and community engagement.
3. Cultivate future STEM talent pool by supporting undergraduate and graduate students.
4. Promote participation of underserved groups.
5. Enhance STEM initiatives using a systematic approach.

The DoD participation in the USASEF was intended to address Goals 1, 2, and 4; the evaluation of the event is an attempt to address Goal 5. From the results, it appears that participation in the USASEF supported the DoD STEM Strategic Plan, but the degree to which the event was a success is not clear because there isn't a well-established metric or a valid comparison to provide context. From this current evaluation, we now have the beginning of a baseline of metrics to which subsequent events can be compared. This ongoing effort to enhance STEM activities in a systematic manner will provide the context for how successful the DoD's participation in the 2018 USASEF was and how to build on those efforts in the future.



## Appendix A.

# Listing of Participating DoD Components and Organizations

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Component	Participating Organization
Army (2829)	Deputy Assistant Secretary of the Army for Research and Technology / Army Educational Outreach Program
	U.S. Army Research, Development and Engineering Command (RDECOM) / Army Research Lab
	RDECOM / Edgewood Chemical Biological Center
	RDECOM / Communications-Electronics Research, Development and Engineering Center (CERDEC)
	RDECOM / CERDEC / Night Vision and Electronic Sensors Division
	Engineer Research and Development Center
	Medical Research and Materiel Command / Walter Reed Army Institute of Research
	U.S. Military Academy / Network Science Center
US Army Recruiting Command	
Naval STEM	Office of Naval Research / Naval STEM Coordination Office (3433)
	Naval Research Laboratory (3249)
	Space and Naval Warfare Systems Command (SPAWAR) (3435)
	US Naval Academy (3437)
Air Force (2831)	Marine Corps Systems Command (3131)
	Air Force Research Lab
Fourth Estate	Defense Health Agency / National Museum of Health and Medicine (3537)
	Defense Threat Reduction Agency (3429)
	National Geospatial-Intelligence Agency (3129)
	Missile Defense Agency (3529)
OSD	National Security Agency (3535)
	OSD Corrosion Policy and Oversight Office (3431)
	OSD STEM Development Office (3328)

Note: Booth number in parentheses.



# Appendix B. Attendee Tracking Form

**Time/date in general DoD Area:**  :

Child (Gr 1-8)      Teen (Gr 9-12)      College Student  
 Parent/Guardian      Teacher/Educator      Adult

White    Asian    Black    Hispanic    Native American    Pacific Islander    N/A

Male      Female



**Interaction:** S = Swag, P = Program info, T = Talk with booth member, E = Engaged in activity, O = Observed activity

**Minutes spent at booth:** # or < 1. Passed by & stopped at diff booth = /. Passed by on way out = X. Unattended = blank.

Army		Air Force	OSD	Fourth Estate	Navy
Army Education Outreach Program (hands-on STEM activity)	Coastal and Hydraulics Lab	AFRL (fly a drone)	DoD STEM (Lightning Talks stage) (talk Y/N) 9:30 10:00 11:00 11:30 12:00 1:00 1:30 2:00 2:30 3:00 4:00 5:00	Nat. Mus.of Health & Med/DHA (TBIs and hold brain)	ONR/Navy Space Cadre Office (Ship of the Future display)
Army Research Lab (simulated drone and AVision technology)	Information Technology Lab	AFRL (lasers/optics)		DTRA (Transportable Isolation System display)	Naval Research Lab (scientists and hands-on demos)
Edgewood Chemical Biological Center	Cold Regions Research and Engineering Lab	AFRL (super oil repellent surfaces)		DTRA (infectious disease activity)	SPAWAR (cyber security activities or simulator drone)
CERDEC (hands-on STEM games)	Med. Research Mat. Com/Walter Reed (termites, roaches, reptiles)	AFRL (navigation w/o GPS)	DoD STEM (VR tour of DoD lab)	DTRA (biosafety cabinet activity)	USNA (fluids, Bernoulli/Archimedes principle)
CERDEC (thermal infrared sensors and night vision goggles)	USMA/Center for Leader and Diversity in STEM	AFRL (build straw rocket)	Corrosion Office (human battery)	NGA (thermal cameras and VR)	USNA (implode marshmallows)
US Army Recruiting Command	USMA/Network Science Center		Corrosion Office (break down H <sub>2</sub> O)	MDA (build tube missile)	USNA (drive robots)
			Corrosion Office (corrosion process)	MDA (infrared sensor demo)	USNA (alt. energy)
				NSA (light spectrum)	USNA (craft plane)
				NSA (secret codes)	USNA (materials fail)
			Navy ASNE (Fleet on fleek game)	NSA (robot catch spies)	Marine Corps Sys. Com (Marine field gear)

**Time out of general DoD Area:**  :



# Appendix C. DoD Response Card

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## Department of Defense (DoD) Response Card

What describes you the best:

- |  |  |
|--|--|
| <input type="checkbox"/> Student grades 1-8                    | <input type="checkbox"/> Parent/guardian of student attendee |
| <input type="checkbox"/> Student grades 9-12                   | <input type="checkbox"/> Teacher/educator                    |
| <input type="checkbox"/> Student in college or graduate school | <input type="checkbox"/> Adult not in above categories       |

Gender:  Male  Female

How would you describe yourself (check all that apply)

- |  |   |
|--|---|
| <input type="checkbox"/> Hispanic or Latino                        | <input type="checkbox"/> American Indian or Alaska Native |
| <input type="checkbox"/> Asian                                     | <input type="checkbox"/> Black or African American        |
| <input type="checkbox"/> Native Hawaiian or other Pacific Islander | <input type="checkbox"/> White                            |

Home Zip Code OR City & State: \_\_\_\_\_

Have you or has anyone in your immediate family served in the U.S. Military?  Yes  No

The next items ask you about STEM, which stands for Science, Technology, Engineering, and Math.

	Yes	No	Not Sure
Have you been to this event in previous years?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If yes, did you visit the DoD exhibit last time?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Would you attend another DoD STEM event, in the future?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

From the DoD area at the Festival...	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I learned interesting STEM information	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I learned about STEM job opportunities at DoD	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am more likely to pursue STEM education or a career	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I found activities in the DoD area engaging	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

What made you decide to visit this area (DoD exhibits)? (Select all that apply)

- I was just passing by
- I wanted to see a particular exhibit; Which exhibit? \_\_\_\_\_
- I have an educational or professional interest; Please explain \_\_\_\_\_
- Other (please specify) \_\_\_\_\_

What DoD exhibit/talk did you like most? Why? \_\_\_\_\_

How about across the entire festival? \_\_\_\_\_

Are you interested in participating in any DoD STEM program(s) that you just learned about?

(Name the program): \_\_\_\_\_

Comments/suggestions: \_\_\_\_\_



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## Abbreviations

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AEOP	Army Education Outreach Program
AFRL	Air Force Research Laboratory
ASNE	American Society of Naval Engineers
CERDEC	Communications-Electronics Research, Development and Engineering Center
DoD	Department of Defense
DTRA	Defense Threat Reduction Agency
GEMS	Gains in the Education of Mathematics and Science
MDA	Missile Defense Agency
NGA	National Geospatial-Intelligence Agency
NSA	National Security Agency
ONR	Office of Naval Research
OSD SDO	Office of the Secretary of Defense STEM Development Office
OSD	Office of the Secretary of Defense
SMART	Science, Mathematics & Research for Transformation
SPAWAR	Space and Naval Warfare Systems Command
STEM	science, technology, engineering, and mathematics
USASEF	USA Science and Engineering Festival
USMA	United States Military Academy
USNA	United States Naval Academy



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1. REPORT DATE November 2018		2. REPORT TYPE FINAL		3. DATES COVERED (From–To) AUG 2018 – NOV 2018	
4. TITLE AND SUBTITLE  Evaluation of DoD's Participation in the USA Science and Engineering Festival				5a. CONTRACT NUMBER HQ0034-14-D-0001	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Belanich, James Dobbins, Christian Moses, Franklin L. Srinivasan, Ruhi Cummings, Melissa A. DeMaio, William A.  O'Connor, Kelly Parrish, Emily M. Venegas, Ana M. Waruhiu, Steven				5d. PROJECT NUMBER AI-2-4016	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  Institute for Defense Analyses 4850 Mark Center Drive Alexandria, VA 22311-1882				8. PERFORMING ORGANIZATION REPORT NUMBER  IDA Document D-10339	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Defense Laboratories Office OUSD(R&E)/Research Directorate 4800 Mark Center Drive Alexandria, VA 22350				10. SPONSOR/MONITOR'S ACRONYM(S)  OUSD(AT&L)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited (7 February 2020).					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT This report is the first independent evaluation of DoD's participation in the USA Science and Engineering Festival held in Washington, DC, on April 6–8, 2018. By observing the movement of attendees through the DoD area, the authors determined that DoD's participation in future STEM festivals could be more effective by: (1) creating a map of the DoD area with more detail and descriptions than the festival map and handing the map out to attendees; (2) providing distractors (e.g., presenters, informational displays, entertainment) or alternative tasks for those in line to make the passage of time seem faster; (3) posting of times for talks and events; and (4) conducting future evaluations so that each iteration of the DoD area can be improved.					
15. SUBJECT TERMS  program evaluation; science festival; STEM					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Lopez, Louie R.
Uncl.	Uncl.	Uncl.	SAR	36	19b. TELEPHONE NUMBER (include area code)
			571-372-6715		