



Engineering Outreach on Campus: A Comprehensive Survey of 109 Programs at 91 Colleges and Universities (Fundamental)

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Abstract

Colleges and universities have mounted significant outreach efforts to present a full, appealing picture of engineering to outside audiences. In spite of nearly pervasive practice, outreach has largely escaped systematic, comprehensive examination. The vast majority of outreach studies have focused on single programs. Attention to outreach as a field of activity at colleges and universities is almost non-existent. As a result, little data are available for consulting on questions such as why colleges and universities do outreach, whom they reach, what kinds of outreach events they offer, how they are staffed and paid for, among many other pertinent issues.

This report, “Engineering Outreach on Campus,” is based on a survey of 109 outreach programs at 91 institutions, conducted in late 2014. The survey asked questions about outreach programs’ purposes and audiences; the types, timing, and location of events offered; and program administration. Results show that engineering outreach is overwhelmingly directed at K-12 audiences, significantly focused on reaching groups under-represented in engineering, conducted in the name of purposes beneficial more to the field as a whole than individual institutions, highly varied in size and approach, and generally run on low budgets.

The benefits of gathering and understanding field-wide data about outreach are many. Most generally, it moves discussion of the field from the realm of anecdote and assumption to empirical data and reasoned analysis. Leaders of programs already in operation might use this information for benchmarking their own activities in relation to generally adopted norms. People starting new programs might take guidance from the distilled experiences of others in the field to initiate more reliably effective programs. Finally, aggregated data drawn from across a wide spectrum of outreach programs allow us to conceptualize outreach as a field in its own right. It can be seen and thought about as a set of activities with related motives and practices, rather than just ad hoc activities conducted among a sphere of local actors towards idiosyncratic ends.

Introduction

The “image” problem of engineering is widely discussed. The National Academy of Engineering’s project, “Changing the Conversation,” lays out effectively all the dimensions of this problem.¹ It details the major facets, from misinformed public perceptions of the field to the lack of diversity to engineers’ poor communications practices to the global competitiveness concerns. And it offers solutions for people to test out in their own communications environments.

In recognition of this “image” problem, colleges and universities have gone heavily into the business of engineering outreach. “Engineering Outreach on Campus” is a report on the current state of these operations. Engineering outreach at colleges and universities takes many forms, with many different kinds of activities, run at many different scales and for many different reasons. This heterogeneity has made the term “outreach” elastic, to say the least, and difficult to theorize. We understand outreach, at its most basic, to involve schools’ efforts to engage external audiences in some kind of learning

experience about some facet of engineering. This learning is typically outside the purview of standards or formal curricula.

Methods and goals

This analysis of engineering outreach is based on a survey conducted from August to December 2014 of colleges and universities conducting engineering outreach activities. Responses were solicited through social media outlets like LinkedIn and Twitter, the Pre-College Engineering Education Division at the American Society for Engineering Education, and direct appeals to hundreds of engineering outreach program administrators across the country.

Responses came from 109 programs at 91 colleges and universities, representing about 20 percent of all engineering degree-granting schools in the United States. “Colleges” in the survey included both two-year institutions offering associate’s degrees and four-year institutions offering bachelor’s degrees. “Universities” included institutions offering both bachelor’s and graduate degrees. The responding programs came from 70 universities, six four-year schools, 11 two-year schools, and four “other” organizations (two non-profit consortia, one education society, and a museum, all affiliated with colleges or universities in some fashion).

The survey was designed to illuminate the contours of engineering outreach, as colleges and universities conduct it. These contours encompass the purpose and audience for outreach programs, types of outreach events run by programs, and administration of outreach programs. Data gathered in all these areas serve to identify trends and notable features among the great variety of approaches people take to the outreach enterprise. Analysis of the results clarifies such trends and features.

The data gathered also provide insights into the choices and motives that individuals and institutions make about why and how to organize and operate outreach programs. As a result, field-wide data about outreach can provide an angle of approach into values people hold about outreach and the audiences it reaches. This paper, thus, also offers some interpretations about the values underlying the practice of outreach.

Uses

This report offers a unique addition to discussions about engineering outreach. Previous reports have looked at engineering outreach at professional societies.² And many catalogues or lists of outreach programs are available online.³ But efforts to gather data and synthesize results into a panoramic summary along the lines of this report seem to be lacking.

Field-wide data and analysis about outreach serve many purposes. Survey results can provide a context in which individual program leaders might see their own programs in relation to larger, field-wide phenomena. Whether for benchmarking programs at their home institutions or for guidance in starting up new programs, this paper offers outreach program leaders an empirical basis for making local decisions about outreach in relation to field-wide practices and values. In addition, analysis of data about outreach as practiced across multiple institutions allows us to see outreach as a field, rather than just as a local operation. Fostering this perspective widely in engineering education is a key step in the

maturation of outreach as an enterprise playing an important role in serving the interests of the larger field as a whole.

Part 1: Purposes and Audiences

“Part 1: Purposes and Audiences” reports on results from the first section of the survey. In this section, we asked people about the purposes their outreach programs were designed to serve and what kinds of people participated in them.

For purposes, respondents could choose among the following:

- Increase awareness of engineering
- Promote engineering as a subject in K-12 education
- Increase diversity in engineering
- Increase recruitment for the host institution

We also asked for audience information in two kinds of ways, first by the type of participant, and second, by demographic profile. The types of participants were:

- Student
- Teacher
- Parent
- Community Member
- Administrator

The demographic profiles were:

- Girl or young woman
- African-American
- Hispanic
- Native American
- Other

We also asked for information about how many members of all these audiences program leaders thought they had reached in the last year. Discussion and tables follow, presenting summaries and analyses of information received on these topics.

Survey respondents

The kinds of institutions that participated in the survey ranged widely. Ninety-one institutions provided 109 responses, and they included major research universities, like the University of Michigan, University of Texas at Austin, Purdue University, and Johns Hopkins University. Regional schools participated, like Southern Connecticut State University, University of South Alabama, and University of Colorado, Colorado Springs. Four-year schools included Smith College, Merrimack College, and Hood College. Among the two-year schools were Cochise College, Cincinnati State Technical and

Community College, and Northern Virginia Community College. A full list of participating institutions is included as an appendix.

Distribution of survey respondents by type of institution		
	Response percentage	Response count
University	78.9%	86
Four-year college	7.3%	8
Two-year college	10.1%	11
Other	3.7%	4
Total	100.0%	109

Of the 109 responses, 86 came from university programs. Subtracting the four “other” responses from the total because they did not come from programs located at post-secondary institutions, we have 105 programs in the survey run directly by colleges and/or universities. The 86 programs at universities are 82 percent of this group.

The responding programs came from 76 different bachelor’s-granting schools (university and four-year), 11 associate’s-granting schools, and four other kinds of institutions. Among the bachelor’s-granting respondents were 70 universities and six four-year schools, so universities made up 92 percent of this cohort. For context, ASEE’s annual survey of engineering schools shows 319 that offer bachelor’s degrees.* Of these, 254, or 80 percent, are universities. Our survey, then, generated a rate of response from universities 12 points higher than the distribution of universities in the field at large. Conversely, four-year schools are under-represented, just 7.9 percent of the total (6/76) compared to 20 percent of the ASEE total (65/319).

Purposes for which institutions do outreach

We defined four purposes for people to choose from, as well as offering an open-ended “comments” option. All 109 full survey responses contained an answer to this question. Among the 20 comments, people identified purposes such as outreach to low-income groups, teacher training, engineering education research, and general engineering literacy. Programs obviously do double- or triple-duty, and there were no limits on how many purposes people could select.

Purposes for doing outreach by type of institution					
Purposes	University (86)	Four-year (8)	Two-year (11)	Other (4)	Total (109)
Increase awareness of engineering	65	6	10	2	83
Promote engineering as a subject in K-12 education	57	8	7	3	75
Increase diversity in engineering	57	6	8	3	74

* Figures are for 2013, available at www.asee.org/colleges, under “Online Profiles/Search the Profiles.” Retrieved on 1/14/15.

Purposes for doing outreach by type of institution					
Purposes	University (86)	Four-year (8)	Two-year (11)	Other (4)	Total (109)
Increase recruitment for the host institution	43	2	9	0	54

The numbers for “recruitment” stood out. Among universities, only 50 percent selected it. By comparison, 76 percent chose “awareness” as a purpose. These schools appear to have conceptualized their outreach more in the service of the field as a whole than as serving a specific institutional goal like recruitment. A student made more “aware” of engineering might well choose a college differently from one specifically “recruited.” At a minimum, “awareness” and “promotion” are more difficult to measure and report on as goals, compared to “diversity” and “recruitment.”

While the numbers are small, “recruitment” is more popular among two-year respondents, though still following “awareness” as the second-most frequently chosen option.

Audiences of outreach programs

One of the strongest results of the survey showed that outreach is overwhelmingly directed at K-12 audiences. All four-year, two-year, and other respondents addressed student audiences. * And all nine university programs not selecting “students” as an audience chose “teachers” instead. The focus on core K-12 audiences is unsurprisingly strong.

Audiences for outreach by type of institution					
Audiences	University (76)	Four-year (6)	Two-year (7)	Other (3)	Total (91)
Students	67	6	7	3	83
Teachers	36	4	3	1	44
Parents	23	3	1	1	28
Community Members	16	3	2	1	22
Administrators	15	2	0	0	17

At the other end of the spectrum, administrators come in for little attention. Considering their influence in making decisions about if and how engineering plays a role in K-12 education, administrators might merit more outreach. Since “promote engineering as a subject in K-12 education” is a stated purpose for just over two-thirds of all programs, the fact that only 18 percent seek to reach administrators could be a strategic disconnect. Administrators are well organized among professional societies and easy to reach through meetings and publications. Principals, for example, have national associations for both elementary and secondary school officials, as well as state-level groups with convening functions.

These low figures could also result from terminological ambiguity: if administrators are more the object of schools’ strategic “communication” rather than “outreach,” their efforts to reach administrators might escape detection in this survey.

* Respondents could choose more than one answer.

Participants in outreach programs

In outreach, students rule.* For all that recruitment per se is the least prevalent purpose among the programs in our survey, programs still see students as key to success in building awareness and enhancing diversity. One would expect them to be the largest group, by a large margin, and they are.

Number and type of participants by institution type for prior program year					
	University (70)	Four-year (6)	Two-year (7)	Other (2)	Totals (85)
Students	143,738	800	2,903	162	147,603
Community Members	78,636	15	300	15	78,966
Parents	26,952	175	10	90	27,227
Teachers	5,508	123	127	18	5,776
Others	1,198	25	1	0	1,224
Administrators	561	4	4	1	570
Totals	256,593	1,142	3,345	286	261,366

To think about these totals in a larger context, we can hone in on the university numbers. The 70 respondents came from 61 different universities, equal to about 24 percent of the ASEE university population, 254. If these schools perform outreach at a level proportionate to their share of the total university universe, the 143,738 students they reach would extrapolate to 598,908 ($143,738/0.24$) for all university programs. To be sure, people doing outreach might be more likely to participate in an outreach survey than those not. We could well have a disproportionate data set. But outreach certainly “feels” like a nearly pervasive activity among universities, and this magnitude of extrapolation is likely to be generally valid.

Three programs reported about 65,000 of the 147,000-plus student total, each with about 20,000 participants. The median figure for student programs was 200. The spiky-ness of participation numbers points up something fundamental about the nature of the field. Outreach is a highly varied undertaking. Different schools have different goals, capabilities, and opportunities. Programs come in all shapes and also all sizes.

The community member total does reflect one unusually large program total that might bear discounting. Some 75,000 of the nearly 79,000 total resulted from one program’s participation in a state fair, a

* The precision of these figures is surely misleading. Some reported figures were round numbers, while others appeared to be more exactly counted totals. Totals are best understood as approximations, for all that the figures are carried out to the 10’s and 1’s digits. Furthermore, the categories are likely not understood in the same way by all respondents. “Community members” in one figure might well include participants reported as “parents,” for example, in another.

redoubtable example of engineering outreach meeting people where they live. Even so, the intensity of the outreach contact might not be comparable to that of other programs. A comprehensive set of data would put this kind of activity into a fuller context, telling us how it relates to other forms of outreach to community members. For now, we might just regard the total as something of a provisional indicator.

A strong emphasis on diversity

The table below shows how widespread diversity is as a focus of outreach.

Does this program reach under-represented groups?		
	Percentage	Count
Yes	72.5%	66
No	14.3%	13
Other	13.2%	12
Total		91

With diversity such a long-standing challenge in engineering, seeing over 70 percent of respondents specifically addressing under-represented groups makes sense. Indeed, among the 12 “other” responses, eight mentioned diversity as an implicit goal and/or identified low-income populations as their intended audience. So the attention to under-represented groups is, if anything, understated in the 72.5 percent figure.

Which under-represented groups does the program seek to reach?					
	University (48)	Four-year (3)	Two-year (7)	Other (1)	Totals (59)
Girls or young women	33	3	7	1	44
African-Americans	24	0	6	1	31
Hispanics	18	3	6	1	28
Native Americans	12	0	4	1	17
All of the above	13	1	0	2	16

Outreach to “girls or young women” was the most commonly reported diversity effort.* Almost three-quarters, or 44, of the 59 responding programs focus on girls, about half each on African-Americans (31) and Hispanics (28), and one-quarter on Native Americans (17). Just under one-quarter report focusing on all groups.

* Respondents could choose more than one answer. From the totals we left out the responses of “All of the above” where respondents had already selected all four of the options individually.

How many members of under-represented groups participated in the last year?					
	University (33)	Four-year (3)	Two-year (7)	Other (1)	Totals
Girls or young women	42,118	75	1,446	47	43,686
Hispanics	28,369	45	619	45	29,078
African-Americans	13,974	n/a	172	14	14,160
Native Americans	1,001	n/a	n/a	3	1,004
Others	16,408	39	73	38	16,558

The “Others” category included participants from economically or educationally challenged environments.

Notwithstanding the close program totals above (African-Americans, 31; Hispanics, 28), Hispanics participated in these programs at a rate nearly twice as high as African-Americans. However, this disparity comes from one program reporting 24,000 Hispanic outreach contacts. Indeed, the same program reported 19,000 girl contacts. The median figures for contacts per program for the three groups were:

- Girls or young women: 72
- African-Americans: 43
- Hispanics: 36

As discussed above, large program totals are part of the outreach landscape. The field could be said to resemble a town, composed mostly of houses and low-rise apartment-buildings, built in many different styles, but also featuring a small number of tall skyscrapers, dramatic contrast to the mostly modest scale of activity common in most parts.

Part 2: Types of Events

“Part 2: Types of Events” reports on results from survey questions asking about the kinds of outreach events that programs offer. We also asked about the location of these events, whether they took place “on-campus” or “in-class.” “On-campus” signified events taking place at the college or university operating the program; “in-class” indicated events taking place at a K-12 school. On-campus events could take place either during the school year or the summer, while in-class events were either during the school day or after school. The final piece of information requested in this section of the survey addressed event audiences, with the choices being: students, teachers, parents, administrators, community members, or others.

We defined types of events as falling into the following categories:

- **Exposure** – field trips, campus visits, fairs, open houses, etc.

- **Observation** – presentations or demonstrations by program representatives in which audiences would only observe, rather than participate.
- **Hands-on** – workshops, exercises, or other activities in which audiences would participate.
- **Observation/Hands-on** – a combination of the preceding two categories, involving a demonstration followed by participatory activities.
- **Multi-day** – summer camps, academies, short courses, etc., designed to provide sustained learning experiences across varied instructional modalities.
- **Internships** – purposeful, substantive work opportunities over a defined period.

The principle underlying this division of events was the escalating intensity of, a) audiences’ contact with program representatives and, b) audiences’ experience with engineering in each successive activity. Exposure events represent the least “intense” exchanges and internships the most “intense,” with the other events falling in between these extremes.

All events are assumed to be time-limited and offered outside formal K-12 curricular activities, i.e., not typically presented by a K-12 teacher and not subject to testing. Within the sphere of outreach, though, they offer highly varied experiences, adaptable to the different needs and interests of the many audiences that outreach programs seek to reach.

Overview of respondents

To review, 91 organizations offering outreach programs responded to the survey, with information about 109 separate programs. In the types of events section of the survey, we gathered information from 68 programs offered at 62 different universities, four from four-year schools, seven from two-year schools, and two from others. Because the numbers for non-university-based programs were so low, we have not included them in the analysis that follows. Discussion and data address only the university-based programs.

The frequency of events offered, by type

The most frequently offered events were the first three: exposure, observation, and hands-on. Of the 68 responding programs, between 59 and 62 (87-91%) offered one or more of these types.

Frequency of event types offered by universities (68)						
	Exposure	Observation	Hands-on	Observation/ Hands-on	Multi-day	Internships
Totals	60	59	62	42	49	13
Students	56	53	57	37	46	11
Teachers	43	37	39	25	23	7
Parents	31	25	22	14	4	1
Administrators	24	19	18	16	9	2
Community Members	24	20	20	18	8	1
Others	11	8	11	6	6	3

In all three cases, the order of most to least frequently served audiences was the same: students, teachers, parents, community members, administrators, and others. These three types of events are bread-and-

butter outreach, staples of any program and easily adaptable to whatever purpose program leaders are working to serve. As we saw with audiences in Part 1, administrators come in for less attention than other sectors. Given their importance as decision-makers, giving administrators short shrift in outreach could be a missed opportunity for securing a higher profile for engineering in K-12 education.

How event types relate to purposes

The outreach practices reported in the survey show what types of events correlate to which purposes programs are serving. As discussed in Part 1, these purposes included: increasing awareness of engineering, promoting engineering in the K-12 classroom, increasing diversity in engineering, and increasing recruitment for the host institution.

The table below shows correlations between types of events and these four purposes. Keep in mind that a single program might be reported as serving multiple purposes. To calculate the correlations, we grouped responses by purpose and then totaled the programs reporting each type of event within each group. The correlation value is the second number divided by the first number. For example, 44 programs reported doing exposure events among the 65 programs working to promote awareness of engineering. The correlation between exposure and awareness is then 44/65, or 0.68.

Correlations between event types and purposes						
Purpose	Exposure	Observation	Hands-on	Observation / Hands-on	Multi-day	Internships
Awareness	0.68	0.58	0.62	0.40	0.49	0.03
Engineering in K-12	0.65	0.65	0.74	0.47	0.56	0.14
Diversity	0.68	0.70	0.70	0.53	0.58	0.14
Recruitment	0.79	0.74	0.79	0.49	0.67	0.21

The order of purposes in the table reflects their ranking from most to least common, as discussed in Part 1. These correlations suggest what practices university outreach leaders believe to be the most effective for each particular purpose.

In other words, if your program is seeking to do “X” purpose, then you should be doing “Y” type of event. Of course, local circumstances will always shape these decisions in a way that survey data do not capture. Even so, here are the events most strongly correlated with each of the four outreach purposes:

- Awareness: exposure, hands-on, observation
- Engineering in K-12: hands-on, exposure & observation, multi-day
- Diversity: observation & hands-on, exposure, multi-day
- Recruitment: exposure & hands-on, observation, multi-day

As would be expected, the most common events – exposure, observation, and hands-on – show up most often. Of note is that the profiles of the most and least common purposes – awareness and recruitment – are the same. Different, though, is the strength of the correlations, higher across the board for recruitment.

Flipping the viewpoint, each type of event is correlated at different strengths to each purpose. Below are the types of events shown with purposes arranged from strongest to weakest correlation:

- Exposure: recruitment, awareness & diversity, K-12
- Observation: recruitment, diversity, K-12, awareness
- Hands-on: recruitment, K-12, diversity, awareness
- Observation/Hands-on: diversity, recruitment, K-12, awareness
- Multi-day: recruitment, diversity, K-12, awareness
- Internships: recruitment, diversity & K-12, awareness

The least common purpose, recruitment nevertheless is correlated most strongly with five of the six types of events. This suggests people using outreach for recruitment are operating a wide variety of outreach events to accomplish their purpose. The most common purpose, awareness, is correlated most weakly with five of the six types, the exception being exposure. Since both have relatively low-intensity attributes, it makes sense that awareness and exposure would be more highly correlated.

How event types relate to audiences

We divided audience segments into two categories: those inside the K-12 classroom and those on the outside. This distinction extends the theme of intensity to audience, assuming students and teachers get more instructionally intense attentions from program leaders, whatever the purpose of the event.

This analysis shows what types of events focused more or less on classroom audiences relative to non-classroom audiences. We counted the number of programs identifying students and/or teachers as their audiences and compared the results to the number of programs identifying parents, administrators, community members, and/or others as their audiences. We do not have data on the proportions of audience segments represented in the programs, so figures show only summary-level information.

The table below shows the ratio of programs addressing the *in-class* K-12 audiences, students and teachers (“IC”), to those addressing the *out-of-class* audiences, parents, administrators, community members, and others (“OC”).

For on-campus events, ratios also appear describing the proportion of school year (“SY”) to summer (“SU”) events. For in-class events, ratios describe the proportion of school day (“SD”) to afterschool (“AS”) events. Tables with the underlying data are in the appendix. The higher the ratio value is, the greater the focus on students and teachers, on school-year events, or on school-day events within the particular event type.

Ratios for audiences, location, and timing by type of event						
	Exposure	Observation	Hands-on	Observation / Hands-on	Multi-day	Internships
Overall*						
IC:OC	1.22	1.45	1.45	1.19	2.87	4.17

* “Overall” figures include an “elsewhere” category not part of “on-campus” or “in-class” results. “Elsewhere” events take place neither “on-campus” nor “in-class.” They tend to skew more heavily towards OC audiences, thus lowering the IC:OC ratios in the overall category relative to the other two categories.

Ratios for audiences, location, and timing by type of event						
	Exposure	Observation	Hands-on	Observation / Hands-on	Multi-day	Internships
On-campus						
IC:OC	1.26	1.54	1.55	1.31	3.69	6.67
SY:SU	1.32	1.36	1.20	1.82	0.30	0.39
In-class						
IC:OC	2.00	3.09	2.56	1.39	2.60	1.00
SD:AS	1.09	1.35	1.47	1.13	1.08	0.00

IC = in-class K-12 audiences (students, teachers)

OC = out-of-class audiences (parents, administrators, community members, others)

SY = school year; SU = summer

SD = school day; AS = afterschool

The table supports some self-evident assumptions we might have about outreach events:

- Stronger focus on students and teachers as the intensity levels increase
 - Exposure events at 1.22, multi-day at 2.87, and internships at 4.17
- Prevalence of smaller, easier-to-mount events during the on-campus school year compared to longer-term, more complex ones
 - Exposure at 1.32, observation at 1.36, multi-day 0.30
- More in-class events with higher intensity levels during the school day than after school
 - Observation at 1.35, hands-on at 1.47 versus exposure at 1.09

The observation/hands-on format, however, stands out. In all categories, the hybrid format's ratios differ noticeably from the related, stand-alone formats, observation and hands-on, which tend to track each other quite closely:

- Weaker focus on students and teachers overall
 - 1.19 compared to observation and hands-on both at 1.45
- More common during the on-campus school year
 - 1.82 compared to 1.36 for observation and 1.20 for hands-on
- Less common during the in-class school day
 - 1.13 compared to 1.35 for observation and 1.47 for hands-on

With 42 out of 68 programs reporting activities in the observation/hands-on category, these results represent a high enough volume of activity to be meaningful. It is not just a question of a data set being too small to be representative. Something about blending the observation and hands-on activities into a single activity changes the calculations people make about when and how to deploy it. The data do not go into enough detail about the nature of events in these categories to support theories about these divergences.

How outreach gets into the classroom

Most outreach activities involve either informal learning or learning outside the purview of technical K-12 standards and assessment. However, engineering is increasingly becoming part of the formal K-12

learning environment. Next Generation Science Standards (NGSS) call out “engineering design” as a core part of the new framework for learning defined in the standards:

From a teaching and learning point of view, it is the iterative cycle of design that offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices.⁴

As of early 2016, 17 states plus the District of Columbia have adopted NGSS as the basis of their science standards.⁵ And engineering content of many forms has proliferated. Third-party curricula include Engineering is Elementary, Project Lead the Way, and The Infinity Project, and schools have also developed their own programs, either on their own or with other institutions, to make engineering a classroom option for students.

We asked three questions to hone in on specifically how outreach programs might be working to bring engineering directly into K-12 classrooms:

- Does this program work to bring engineering into the K-12 classroom through student teachers, GK-12 activities, co-teaching by K-12 teachers and professors, or other means?
- Does this program provide K-12 teacher professional development?
- Does this program seek to develop K-12 engineering curriculum?

Results showed an even distribution of responses across all three of these areas. Numbers in parentheses show the total number of programs in each area that participated in the survey.

How outreach programs get into K-12 classrooms			
	Engineering in the K-12 classroom	Professional development	K-12 engineering curriculum
Universities (86)	37	39	35
Four-year schools (11)	2	3	2
Two-year schools (8)	5	5	3
Totals	44	47	40

Each of these three areas contained different kinds of activities.

- “Engineering in the K-12 classroom”: presentations and demonstrations, students and teachers leading or co-teaching K-12 classes, pre- and in-service training for teachers, students and/or professors mentoring teachers and students, afterschool activities.
- “Professional development”: school-year and summer instructional programs, workshops at conferences, online learning programs.
- “K-12 engineering curriculum”: implementation and/or adaptation of adopted curricula (PLTW, EiE, etc.), implementation of NGSS coursework and materials, curriculum projects unique to university-school partnerships, joint projects between schools of education and engineering, collaboration on teacher-drafted project-based learning materials.

As NGSS gets more fully implemented, engineering stands good odds of an even greater profile inside the formal K-12 environment. Books, courses, tests, and teacher training activities are likely to increase

in number and sophistication. Engineering programs active in this area will be well positioned to shape the direction of these trends.

Competitions as part of outreach

Twenty-four university programs reported competitions as part of their outreach activities. The most common were FIRST and Science Olympiad.

The full list of all reported competitions appears below, with the numbers of respondents reporting each shown:

- FIRST, 8
- Science Olympiad, 6
- BEST Robotics, 3
- TEAMS, 3
- LEGO League, 2
- SeaPerch, 2
- ACM Programming Contest
- Creative Design Competition
- Destination Imagination
- Get Excited About Robotics (GEAR)
- Intel Science & Engineering Fair
- LEGO Mindstorms
- MathCounts
- MAVBOT
- MESA National Engineering Design Competition
- Rube Goldberg Machine Contest
- Technology Student Association Competitions
- TexPrep Bridge-Building Competition & Website Design

Part 3: Outreach Program Administration

“Part 3: Outreach Program Administration” includes presentations of data gathered about budgets, staffing levels, and assessment and reporting practices.

Within the budget section, we asked for total budget figures as well as break-outs including salaries, supplies, travel, and others. Thirty-two universities, one four-year school, and five two-year schools provided information for at least overall budget totals. The discussion below addresses general features of the budget data as well as the sources of programs’ funding. The appendix offers the full table of budget figures that programs submitted.

In the staffing section, we asked for numbers of professors, graduate students, undergraduates, professional staff, administrative staff, and others. We got responses here from 56 universities, six four-year schools, and three two-year schools. We present the results below as averages across these categories.

The assessment and reporting section details the frequency and kinds of assessment programs carry out and to whom they provide this information.

Budgets and staffing

Befitting the largely local scope of most outreach programs, budget data show mostly small-scale financial operations. Twenty-three of the 32 university-based programs reported budgets of \$100,000 or less. However, five programs reported budgets of \$1,000,000 or higher, with the highest total being \$6,000,000.*

The average overall budget was \$434,457, and the median was \$45,000. The table in the appendix provides detail about salaries, supplies, travel, and other categories. Most programs are clearly scuffling for money, and these figures no doubt leave out a great deal of uncompensated time and effort.

We also asked about the sources of programs' funding. The top sources were, in order: grants, home institution support, and donations. Among universities, the most well-funded programs also had the most well-diversified funding base. Six of the top nine budgets were associated with at least three sources of funding, and all had at least two. By contrast, six of the bottom nine had only one funding source, two reported two sources, and one reported three. The table below shows data for all three categories of institutions, with the number of respondents in parentheses.

Sources of outreach program funding						
	Grants	Home institution	Donations	Sales	Contracts	Other [†]
Universities (56)	37	28	24	8	6	8
Four-year (6)	3	5	0	1	2	1
Two-year (3)	3	1	1	1	0	1

[†]Answers in the "other" category included tuition, event fees, and government appropriations.

Thirty-two university-based programs reported an average of 10.7 staff members. Categories of program staff included professors, graduate students, undergraduates, professional staff, and administrative staff. This total includes full- and part-time positions as well as any positions shared with other operational units.[†]

Average staffing levels, by institutional position						
	Professor	Graduate student	Under-graduate	Professional staff	Administrative staff	Total
Average	4.7	4.5	8.3	4.1	2.7	10.7
Median	3.0	2.0	10.0	2.5	2.0	10.0

* Just one four-year program responded, reporting a budget of \$550,000. Five programs at two-year schools responded, with budgets ranging from \$5,000 to \$200,000. The average was \$83,000, and the median \$80,000.

[†] The average for four-year schools was 9.0, based on three responses. The average for two-year schools was 5.67, based on six responses.

Assessment and reporting

If assessment practices reveal what people really care about, then people care a lot about outreach. Of 62 responses, 52 university-based programs reported ongoing program assessment regimes.* The most common features of assessment activities were, by far, qualitative surveys, learning assessments, and participant tracking. Everything else occurred far less often.

Assessment activities			
	Universities	Four-year schools	Two-year schools
Qualitative surveys	18	1	2
Learning assessments	15	1	1
Participant tracking	10	0	1
Work produced by participants	3	0	0
Recruitment yield	2	0	1
Adoption of services, products	2	0	0
Observations	2	1	0
Focus groups	1	0	0
External evaluation	0	1	0

These assessments generate results used in almost all cases for reporting. Forty-eight of 62 university-based programs deliver reports on their program activities. In almost all cases, these reports go to home institution administrators and/or funders. Many also go to partner institutions, the general university community, state-level education organizations, or publications both academic and popular.

For 35 programs, reporting on activities really matters, being a condition of funding.

Conclusions

Outreach is one of the most public faces of engineering education. We all come to recognize this fact by anecdote, experience, and observation. However, quantitative and qualitative data showing the defined features of this public face have been rarely gathered and hard to find.

This report illuminates features of engineering outreach with concrete field data. It shows that outreach is heavily oriented towards K-12 audiences, widely practiced, reaches large numbers of people in diverse audiences, and encompasses many different kinds of activities. It also shows that schools bring different levels of commitment to outreach, if money is any indication. The disparities in budget levels – with the average program budget being \$434,457 and the median \$45,000 – show perhaps generally more tolerance than enthusiasm for the activity. Passionate, resourceful individuals are clearly fueling the engine of outreach at colleges and universities.

None of these conclusions is necessarily surprising. But it is one thing to feel something is true, and it is another to have the data to show it. For all that outreach has become a common activity, it is not commonly studied beyond the level of individual program activity.

* Among four-year respondents, three of three reported assessment activities. For two-year schools, four of seven did so.

With field-wide data hard to come by, individual practitioners have trouble understanding their operations in any larger context of norms or standards. They might have trouble identifying programs comparable to their own for self-assessment or connecting with peers in the field to compare notes. Organized networks specifically oriented to outreach program leaders just do not exist. A next step towards accomplishing this goal would be figuring out how to make claims for the impact or benefits of outreach on the wider field of engineering education. Work on this topic is only just beginning.⁶

This report can serve to aid in the development of outreach into a mature, self-aware, well-connected field of activity. It is meant to help disseminate understanding about how people think about and practice outreach, how they organize their operations towards specific goals, and how they function within their larger, institutional contexts.

Appendix to Part 1 – List of survey participants

Many participants submitted information for multiple programs. In these instances, the institution's name shows up only once in this list, even if it is represented more than once in survey data.

AIMS Community College	Two-year college
Akron University	University
Auburn University	University
California State University East Bay	University
Case Western Reserve University	University
Central Washington University	University
Cincinnati State Technical and Community College	Two-year college
City College of New York, CUNY	University
Cleveland State University	University
Cochise College	Two-year college
Dalton State College, GA Northwestern Technical College	Four-year college
Elon University	University
FAMU-FSU College of Engineering	University
George Mason University	University
Heritage University	University
Hong Kong University of Science and Technology	University
Hood College	Four-year college
Hope College	Four-year college
Indian River State College	Two-year college
James Madison University	University
Johns Hopkins University	University
Kent State University	University
Los Angeles Harbor College	Two-year college
Louisiana State University	University
M2SE	Non-profit
Merrimack College	Four-year college
Millersville University	University
Minnesota State University, Mankato	University
Minuteman Regional Vocational Technical School	High School
Mississippi State University	University
Monash University	University
Montana State University	University
Monterey Peninsula College	Two-year college
New Jersey Institute of Technology	University
Northern Illinois University	University
Northern Virginia Community College	Two-year college
Ohio Technology and Engineering Educators Association	Education association
Oklahoma City Community College	Two-year college
Penn State Erie, The Behrend College	University
Princeton University, Rider University, and the Raritan Valley Community College in New Jersey	University
Purdue University	University
Queensland University of Technology	University
Santa Ana College	Two-year college
Santa Clara University	University
Smith College	Four-year college

Southern Connecticut State University	University
Southwestern College	Two-year college
Stephen F. Austin State University	University
Stevens Institute of Technology	University
Technical University of Eindhoven	University
Texas Tech University	University
Texas Wesleyan University	University
The Ohio State University	University
Triton College	Two-year college
Tufts University	University
United States Naval Academy	University
University of Arizona	University
University of California	University
University of Colorado, Boulder	University
University of Colorado, Colorado Springs	University
University of Colorado, Denver	University
University of Connecticut	University
University of Houston	University
University of Maryland, Baltimore County	University
University of Michigan	University
University of Michigan, Dearborn	University
University of Minnesota	University
University of Mississippi	University
University of Nebraska, Omaha	University
University of New Hampshire	University
University of New Mexico	University
University of Pennsylvania	University
University of South Alabama	University
University of South Carolina	University
University of South Florida	University
University of Texas, Arlington	University
University of Texas, Austin	University
University of Texas, Dallas	University
University of Texas, Pan American	University
University of Texas, Tyler	University
University of Toronto	University
University of Utah	University
University of Virginia	University
Vanderbilt University and the Harpeth Hall School	University
Virginia Polytechnic and State University	University
West Virginia University	University
Wichita State University	University
Worcester Polytechnic Institute	University

Appendix to Part 2 – Summary tables

These tables describe results provided by 68 programs operating at 62 universities. Single programs might serve multiple audiences at various times in different places. As a result, totals suggest only relative prevalence of program attributes shown in a particular table.

Exposure events

Programs offering exposure events (universities only)

Audiences	On-campus	In-class	Elsewhere	Totals
Students	52	21	20	93
Teachers	39	13	11	63
Parents	25	7	11	43
Administrators	18	5	10	33
Community Members	19	2	14	35
Others	10	3	4	17
Totals	163	51	70	

Exposure events: On-campus, by time

	School year	Summer	Totals*
Students	38	35	52
Teachers	28	23	39
Parents	20	11	25
Administrators	14	8	18
Community Members	16	10	19
Others	7	6	10
Totals	123	93	163

Exposure events: In-class, by time of day

	School day	Afterschool	Totals*
Students	19	17	21
Teachers	10	6	13
Parents	3	6	7
Administrators	3	2	5
Community Members	1	1	2
Others	1	2	3
Totals	37	34	51

*These totals will not represent the sum of the preceding columns, as programs often offer events in both categories of time for individual audiences.

Observation events

Programs offering observation events (universities only)

	On-campus	In-class	Elsewhere	Totals
Students	47	23	13	83
Teachers	33	11	11	55
Parents	20	3	8	31
Administrators	13	5	9	27
Community Members	13	2	11	26
Others	6	1	4	11
Totals	132	45	56	

Observation events: On-campus, by time of year

	School year	Summer	Totals*
Students	33	33	47
Teachers	24	18	33
Parents	17	9	20
Administrators	11	3	13
Community Members	11	6	13
Others	3	4	6
Totals	99	73	132

Observation events: In-class, by time of day

	School day	Afterschool	Totals*
Students	20	15	23
Teachers	9	5	11
Parents	1	3	3
Administrators	3	2	5
Community Members	1	1	2
Others	1	0	1
Totals	35	26	45

*These totals will not represent the sum of the preceding columns, as programs often offer events in both categories of time for individual audiences.

Hands-on events

Programs offering hands-on events (universities only)

	On-campus	In-class	Elsewhere	Totals
Students	51	27	13	91
Teachers	31	14	12	57
Parents	17	6	9	32
Administrators	13	6	9	28
Community Members	14	3	10	27
Others	9	1	5	15
Totals	135	57	58	

Hands-on events: On-campus, by time of year

	School year	Summer	Totals*
Students	37	36	51
Teachers	21	22	31
Parents	14	6	17
Administrators	10	5	13
Community Members	12	6	14
Others	4	7	9
Totals	98	82	135

Hands-on events: In-class, by time of day

	School day	Afterschool	Totals*
Students	22	17	27
Teachers	13	6	14
Parents	2	4	6
Administrators	5	1	6
Community Members	1	2	3
Others	1	0	1
Totals	44	30	57

*These totals will not represent the sum of the preceding columns, as programs often offer events in both categories of time for individual audiences.

Observation/hands-on events

Programs offering observation/hands-on events (universities only)

	On-campus	In-class	Elsewhere	Totals
Students	31	17	8	56
Teachers	20	8	9	37
Parents	10	5	4	19
Administrators	11	6	7	24
Community Members	13	6	9	28
Others	5	1	1	7
Totals	90	43	38	

Observation/hands-on events: On-campus, by time of year

	School year	Summer	Totals*
Students	24	17	31
Teachers	14	10	20
Parents	10	2	10
Administrators	9	4	11
Community Members	11	3	13
Others	3	3	5
Totals	71	39	90

Observation/hands-on events: In-class, by time of day

	School day	Afterschool	Totals*
Students	13	11	17
Teachers	4	5	8
Parents	1	4	5
Administrators	5	1	6
Community Members	3	3	6
Others	1	0	1
Totals	27	24	43

*These totals will not represent the sum of the preceding columns, as programs often offer events in both categories of time for individual audiences.

Multi-day events

Programs offering multi-day events (universities only)

	On-campus	In-class	Elsewhere	Totals
Students	40	9	8	57
Teachers	19	4	6	29
Parents	2	2	0	4
Administrators	5	1	4	10
Community Members	5	2	2	9
Others	4	0	3	7
Totals	75	18	23	

Multi-day events: On-campus, by time of year

	School year	Summer	Totals*
Students	12	35	40
Teachers	5	19	19
Parents	1	2	2
Administrators	1	5	5
Community Members	1	5	5
Others	1	4	4
Totals	21	70	75

Multi-day events: In-class, by time of day

	School day	Afterschool	Totals*
Students	7	7	9
Teachers	4	2	4
Parents	0	2	2
Administrators	1	0	1
Community Members	1	1	2
Others	0	0	0
Totals	13	12	18

*These totals will not represent the sum of the preceding columns, as programs often offer events in both categories of time for individual audiences.

Internships

Programs offering internships, (universities only)

	On-campus	In-class	Elsewhere	Totals
Students	13	2	2	17
Teachers	7	0	1	8
Parents	0	1	0	1
Administrators	1	0	0	1
Community Members	0	0	1	1
Others	2	1	0	3
Totals	23	4	4	

Internships: On-campus, by time of year

	School year	Summer	Totals*
Students	6	8	13
Teachers	1	7	7
Parents	0	0	0
Administrators	0	1	1
Community Members	0	0	0
Others	0	2	2
Totals	7	18	23

Internships: In-class, by time of day

	School day	Afterschool	Totals*
Students	0	2	2
Teachers	0	0	0
Parents	0	1	1
Administrators	0	0	0
Community Members	0	0	0
Others	0	1	1
Totals	0	4	4

*These totals will not represent the sum of the preceding columns, as programs often offer events in both categories of time for individual audiences.

Appendix to Part 3 – Budget table

Outreach program budgets for university-based programs

Thirty-two university-based programs reported at least partial budget figures for their outreach activities.

Total	Salaries	Supplies	Travel	Other
\$6,000,000	\$1,000,000	\$250,000	\$175,000	\$4,575,000
\$2,200,000	\$1,586,000	\$143,000	\$110,000	\$361,000
\$1,300,000				
\$1,000,000	\$500,000	\$420,000	\$80,000	
\$1,000,000	\$500,000	\$195,000	\$5,000	\$300,000
\$513,708	\$345,774	\$167,934		
\$500,000	\$150,000	\$100,000		\$250,000
\$350,000	\$170,000	\$10,000	\$16,000	\$154,000
\$250,000	\$125,000	\$100,000	\$25,000	
\$100,000				
\$100,000	\$90,000	\$10,000		
\$65,000	\$45,000	\$20,000		
\$55,000	\$35,000	\$10,000		\$5,000
\$52,500	\$45,000	\$2,500	\$5,000	
\$50,000	\$25,000	\$5,000	\$5,000	\$15,000
\$50,000		\$1,000		
\$40,000				
\$40,000	\$16,000	\$1,000	\$3,000	\$20,000
\$40,000	\$15,000	\$5,000		\$20,000
\$30,000				
\$30,000	\$25,000	\$4,000	\$500	\$500
\$30,000	\$5,000	\$2,000	\$500	
\$25,000	\$10,000	\$10,000	\$5,000	
\$17,000	\$11,000	\$6,000		
\$15,776	\$13,276	\$1,500	\$1,000	
\$15,000		\$15,000		
\$10,000				
\$10,000	\$2,000	\$6,000		\$2,000
\$10,000	\$7,000	\$1,000	\$1,000	\$1,000
\$3,200	\$3,000	\$200		
\$400		\$400		
\$30	\$15	\$15		

References

¹ All materials are accessible online at: <http://www.engineeringmessages.org>.

² See, for example: Poole, Susan J., Janet L. DeGrazia, and Jacquelyn Sullivan, (2001) "Assessing K-12 Pre-Engineering Outreach Programs," in *Journal of Engineering Education*, 90(1): 43-48; NAE, (2002) "Raising Public Awareness of Engineering." Washington, DC: National Academies Press (source of the famous \$400 million/year estimate of engineering societies' outreach expenditures); Jeffers, Andrew T., Angela G. Safferman, and Steven I. Safferman, (2004) "Understanding K-12 Engineering Outreach Programs." *Journal of Professional Issues in Engineering Education and Practice*, 130(2): 95-108 (a rare, broad look at university-based outreach); NAE, (2011) "The Bridge: Linking Engineering and Society," *Changing the Conversation about Engineering*. Washington, DC: National Academy of Engineering; Bogue, Barbara, Elizabeth Cady, and Betty Shanahan, (2013) "Professional Societies Making Engineering Outreach Work: Good Input Results in Good Output." *Leadership and Management in Engineering*, 13(1): 11-26; Bogue, Barbara, Betty Shanahan, Rose Marra, and Elizabeth Cady, (2013) "Outcomes-Based Assessment: Driving Outreach Program Effectiveness." *Leadership and Management in Engineering*, 13(1): 27-34.

³ See, for example: National Academy of Engineering, www.engineergirl.org; Career Cornerstone Center, <http://www.careercornerstone.org/pcsumcamps.htm>; Engineering Education Service Center, http://www.engineeringedu.com/store/index.php?route=information/information&information_id=8; and almost every engineering society's website.

⁴ National Research Council, 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. Pp. 201-2.

⁵ Retrieved from <http://academicbenchmarks.com/next-generation-science-standards-adoption-map/> on 1/22/16.

⁶ See, for example, Noah Salzman and Matthew Ohland. (2013) "Precollege Engineering Participation Among First-Year Engineering Students." *Fifth Annual First Year Engineering Experience Conference (FYEE)* Retrieved from http://works.bepress.com/noah_salzman/2/.