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Pre-College Outreach at a Technical Conference*

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A strong technical workforce is essential in a technology-based society. The selection of science, technology, engineering, and mathematics (STEM) electives and of related careers is influenced by familiarity with and perceptions of engineering. Pre-college students need significant opportunities to interact with engineering professionals and to investigate engineering careers. Also, pre-college teachers can gain insight into engineering through such experiences. Technical conferences attract professionals from industry and academia and showcase technologies. Hence, a conference venue can serve as an enriching environment for a pre-college program. Outreach activities for students and teachers were held at the IEEE GLOBECOM Conference. The participants interacted with conference attendees in selected conference activities and dedicated pre-college events. After the conference, the participants shared this experience at their schools. The assessment examined the effectiveness of the interactions and the appropriateness of selected conference activities. The approach can serve as a model for other conference-based outreach programs.

Keywords: pre-college outreach; K-12 education; STEM careers; engineering conference

INTRODUCTION

A STRONG TECHNICAL WORKFORCE is essential in a technology-based society. Sufficient numbers of pre-college students must recognize career opportunities in engineering and must select electives in science, technology, engineering, and mathematics (STEM). However, engineering work and career opportunities are often not well understood by students in general. Engineering professionals should encourage interested students and promote the selection of engineering careers. Outreach outcomes should include giving students the opportunity to interact with engineering professional and to investigate engineering environments. Pre-college teachers can also benefit from such experiences. Personal insight into engineering careers can positively influence STEM teaching [1]. Outreach efforts often target in-school programs, university summer camps, and other dedicated events [2–5]. These programs are effective, but they do not give much exposure to actual professional environments.

Technical conferences attract professionals from industry and academia and showcase technologies. Conferences are widely sponsored by technical societies and are held in many different locations. As such, conferences offer the potential to provide the pre-college audience with significant opportunities to learn from engineering professionals and to gain insight into engineering careers. Also, most technical societies have members interested in pre-college education. An effective pre-college program at a conference must create a positive experience in the professional setting. However, the primary purpose of a conference is to support the technical interests of the attendees. Consequently, the activities are tailored for the professional audience and the information is typically at a high level. To be an enriching pre-college environment, conference components must be selected or created that meet pre-college needs.

This work describes a pre-college outreach program held in the context of a technical engineering conference. The pre-college program was integrated in the GLOBECOM Conference of the Institute of Electrical and Electronics Engineers (IEEE). The participating high school students and teachers interacted with conference attendees in selected conference activities and learned about engineering through dedicated pre-college events. As a post-conference activity, the students described their experiences and their perception of engineering in presentations at their home schools. The assessment examined the effectiveness of the interactions and the appropriateness of selected conference activities. The program organization, implementation, and assessment are shown. The approach can serve as a model for other conference-based outreach programs.

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PRE-COLLEGE OUTREACH

Objectives and scope

The program intent was to use a conference environment for pre-college outreach. Pre-college students and teachers were given the opportunity to observe a wide range of engineers from industry and academia and to interact with these professionals in a variety of selected settings. The conference components were selected for pre-college appropriateness and were integrated with dedicated pre-college activities. The pedagogical objectives for this implementation were to determine:

- the effectiveness of one-on-one interaction among teachers, high school students, engineering students, and working engineers through a conference environment;
- the appropriateness of plenary sessions, exhibits, and student programs in technical conferences as pre-college outreach activities; and
- the perceptions of participating students and teachers of engineering work.

The organization of the program was a formal part of the conference planning. It incorporated professional topics, provided exposure to engineering technologies, and introduced technical skills. The students and teachers participated in activities at the conference and conducted follow-up presentations at the partner schools.

Participants

The program was designed to benefit both pre-college students and teachers. The selection process was intended to promote a commitment among the school, administration, the teachers, and the students [6]. Schools were identified with a record of successfully preparing students for engineering study. Selected schools were asked to identify an active STEM teacher. In turn, this teacher identified two students for the program who had an interest in science and technology. The students and teachers agreed to attend the pre-college program, to complete the assessment, and to conduct a post-conference event at their schools. The school administration documented its support of the participation by the teacher and students and formally agreed to the required follow-up event. Also, the attending teachers as representative of their schools were required to have responsibility for their students during the program.

Seventeen students and ten pre-college teachers from schools in Missouri, Texas, and New York participated in the GLOBECOM program. The student participants were nine males and eight females of which there were ten seniors, four juniors, and three sophomores. The teachers were five males and five females; they were mathematics, physics, biology, chemistry, and technology specialists in public schools with an average six years of classroom experience. In addition, the post-conference in-school events reached approximately 500 pre-college students in the participating schools.

Pre- and post-conference schedule

Planning and preparations for the pre-college program involve both conference organization and pre-college participant arrangements. The pre- and post-conference schedule consisted of the following milestones.

One year before conference

- Approve of the pre-college program by the conference organizing committee
- Appoint organizers for the pre-college program
- Reserve facilities for program components and lodging in the conference hotel

Six months before conference

- Identify partner schools and teachers
- Confirm presenters/trainers for Robotics, luncheon presentation, and soldering workshop
- Obtain sponsors and materials such as kits, career handouts, college information, etc.

Three months before conference

- Obtain preliminary list of students and request school and participant agreements
- Organize college student assistants, invite luncheon table hosts, schedule robotics demonstration, etc.
- Finalize program components and schedule

One month before conference

- Finalize list of teachers and students (all complete agreement and background survey)
- Finalize travel and lodging arrangements with schools and send program packet with agenda to participants
- Confirm facilities reservations and activities with conference committee

After conference

- Report to conference committee
- Provide reimburse for school expenses and collect assessments
- Attend and document post-conference events at partner schools

The number of teachers and student invited were limited by program funding for travel, meals, lodging, etc. and by facilities for the dedicated hands-on activities.

The participants received the conference registration carry-all bag and other take-home items. The carry-all bag contained the conference program, the conference CD, exhibit hall information, and sponsor information. Also, pre-college items were included such as the ASEE *Engineering Go For It* magazine, catalogs from Edmund Scientific and Lego Education, pre-engineering career handouts from IEEE-USA, and college admission and career materials. After the conference, the participants were sent an evaluation survey, a

conference polo shirt, a press release template, a photographic CD, and material for the in-school presentation, e.g. a PowerPoint template and conference graphics.

CONFERENCE ACTIVITIES

Conference venue

The conference venue was sponsored by the Communications Society of the Institute of Electrical and Electronics Engineers (IEEE). The pre-college program was included as a formal part of the 2005 IEEE GLOBECOM (Global Communications) conference that was held in St. Louis, Missouri. This international annual event for electrical and computer engineers presented research and industry developments in voice, data, image, and multimedia communications technologies [7]. The event included pre- and post-conference workshops on Monday and Friday and the conference itself had technical presentations, vendor exhibits, and business meetings on Tuesday through Thursday. Over 1300 professionals from 42 countries were in attendance and over 750 technical papers were presented. The conference planning and organization was performed by a volunteer host committee from the St. Louis IEEE Section with assistance from full-time IEEE Communication Society staff and other IEEE member volunteers.

The pre-college program was proposed and administered by the authors as part of their involvement in the conference host committee. The conference host committee and the IEEE Communications Society GLOBECOM committee approved the pre-college activities as a formal part of the conference. The National Science Foundation provided most of the program funding, e.g. travel, lodging, meals, and project supplies, with supplemental funding coming from Sprint. The conference host committee provided complimentary registrations, conference proceedings, conference polo shirts, and other conference give-aways for teacher, students, and program assistants; the nearby St. Louis University provided facilities for the off-site activities; and the University of Missouri-Rolla (now the Missouri University of Science and Technology) provided pre-engineering materials. The on-site responsibilities of the three authors included a coordinator who was present for all activities (and who coordinated the parallel university student program), a transportation coordinator, and a conference liaison for programming and facilities components. Other key responsibilities were the coordination of the two interactive activities, i.e. the robotics and electronics projects. The IEEE Region 5 Director, other engineering professionals, and university students assisted with various aspects of the program and provided additional interaction opportunities.

Fig. 1. Pre-college Participants at the GLOBECOM Conference.

Schedule of activities

The pre-college program was held during the main three days of the conference. Tuesday morning and Thursday afternoon were allotted for travel to and from the conference. The participants were lodged at the main conference hotel to closely link their experience with the conference. Program activities were scheduled from Tuesday afternoon through Thursday morning. The schedule consisted of:

- Tuesday afternoon and evening—Robotics instruction and competition activity
- Wednesday morning—Conference speakers' breakfast and conference plenary session
- Wednesday morning—University-student technical posters session and the conference exhibits. (The teachers assisted with judging the student poster competition.)
- Wednesday afternoon—Educator luncheon, engineering careers presentation, and hands-on electronics soldering project
- Wednesday evening—Conference banquet and keynote speaker
- Thursday morning—Conference plenary session and free time for conference activities or sightseeing

Note that the pre-college program was integrated with the university student program, i.e. the student poster session and competition on Wednesday morning. The pre-college coordinator was also the student program coordinator, interested teachers were used as part of the judging team for the student poster competition, and the poster award winners attended and were recognized at the educator luncheon. Figure 1 shows the participants in the exhibit hall.

The program activities were tailored to the program objectives and to the participant needs as shown in Table 1. Dedicated pre-college activities were alternated with conference events. The beginning activities combined orientation and get-acquainted functions with an interactive experience and a demonstration with robotics. The LEGO kits and the programming [8, 9] level were consistent with a high school background. The poster session and conference exhibits provided a view of research, applications, and technologies while the educator luncheon and speaker addressed careers. The soldering project provided a

Table 1. Design of the Outreach Program

		Outreach function		
	Program focus	**Professional**	**Engineering**	**Skills**
Robotics	Get-acquainted		Robotics applications	Programming
Plenary speakers	Conference participation	Technology applications		
Conference student posters	Interaction with college students		Examples of research	
Conference exhibits	Interaction with companies		Examples of technology	
Luncheon and careers speaker	Interaction with engineers	IEEE careers overview		
Electronics solder project	Take-home	College environment		Soldering
Banquet and keynote	Recognition	Technologies overview		

hands-on skills component and a take-home item. The banquet, keynote speaker, and plenary speakers gave a view of the breadth of communications technology and of related career opportunities. All activities provided opportunities for one-on-one interaction, either formally or informally.

Description of activities

The participants were introduced to the program and to each other through the robotics session. The purposes were to apply engineering concepts and to perform an interactive team-based activity in which the preparation and tasks could be done in a limited timeframe [8]. Each school formed a team and worked with a laptop, a Lego kit, and a Robolab RCX programming brick [10]. Hands-on training using a 'telling' and 'showing' method [11] allowed the participants to assemble and program Lego vehicles. A race competition provided a 'doing' component to apply the selected concept of wheel and gear combinations for a desired speed or travel time. A robotics demonstration by university students was also given. Figure 2 shows winners of the robotics competition.

The participants then attended conference activities. They gained insight into the scope of the conference and of communications through the speakers' breakfast and the plenary session on communication network services by Jonathan Turner of Washington University at St. Louis. The program coordinators explained the functions of each event. The participants were introduced to research and applications through the university-student poster session and the conference exhibits. Both components allowed the participants to have one-on-one interactions with college students and working engineers.

Fig. 2. Award presentation for the Robotics Competition.

The participants balanced the day with more dedicated activities. An educator luncheon included invited university professors and college students who were placed at each table as conversation hosts. The formal component of the luncheon had recognition of the student poster session winners and a presentation on engineering career opportunities by Robert Scolli, IEEE Region 5 Director. An afternoon soldering workshop at the nearby St. Louis University provided all participants with a take-home electronics project and additional interaction with college faculty and students.

The participants attended and were recognized at the conference banquet. In addition to seeing the scope of the conference activities and the engineering community, they heard the keynote address by Jeffrey M. Jaffe, President of Bell Labs Research. His discussion of future technologies for consumer applications was particularly suited for the pre-college participants. A second plenary session was optional and was a discussion of network security by Joan Woodard, Executive Vice-President of Sandia Laboratories.

POST-CONFERENCE ACTIVITIES

Evaluation survey

The student and teacher participants completed a survey regarding the program. The value of each program component was rated, the program components were ranked, and other aspects of the experience were evaluated. The survey questions and average results are shown in Tables 2, 3, and 4. The most valued program components were the hands-on activities with the Robotics and the

Table 2. Results from the participant survey on program component value

Survey questions on program component value Please use the following scale to rate the value of the . . . **Little value** 1 . . . 2 . . . 3 . . . 4 . . . 5 . . . 6 . . . 7 . . . 8 . . .9 . . . 10 **Much value**	**Average response**	
	Students	**Teachers**
Tuesday Robolab Training, Contest, and Robotics Demonstration	8.3	9.3
Wednesday Plenary Session by Professor Jonathan Turner, Washington University	6.1	5.3
Wednesday Viewing of the student poster session	5.3	5.7
Wednesday Viewing of the GLOBECOM Exhibits	6.6	6.9
Wednesday Lunch with Engineering Educators and IEEE Presentation	7.6	7.9
Wednesday Take-home Electronics Kit Experience	8.8	9.3
Wednesday Conference Banquet (with keynote talk)	7.4	8.1
Thursday Plenary Session by Joan Woodard, Executive VP of Sandia Labs*	6.7*	7.2*
Individual interaction with engineering educators, students, and conference attendees	6.8	8.6

* The Thursday Plenary Session was optional and unrated by many participants.

Table 3. Results from the participant survey on program component ranking

Survey question on program component ranking Please rank the program components (use each number only once) **Least beneficial** 1 . . . 2 . . . 3 . . . 4 . . . 5 . . . 6 . . . 7 . . . 8 **Most beneficial**	**Average response**	
	Students	**Teachers**
Tuesday Robolab Training, Contest, and Robotics Demonstration	5.8	6.8
Wednesday Plenary Session by Professor Jonathan Turner, Washington Univ.	3.3	2.0
Wednesday Viewing of the Student Poster Session	3.3	4.0
Wednesday Viewing of the GLOBECOM Exhibits	4.3	3.8
Wednesday Lunch with Engineering Educators and IEEE Presentation	5.1	5.5
Wednesday Take-home Electronics Kit Experience	7.1	7.1
Wednesday Conference Banquet (with keynote talk)	4.3	4.3
Thursday Plenary Session by Joan Woodard, Executive VP of Sandia Labs*	2.6*	3.7*

* The Thursday Plenary Session was optional and unranked by many participants.

Table 4. Results from the participant survey on other program issues

Survey questions on miscellaneous issues Please use the following scale to respond to . . . **Disagree** 1 . . . 2 . . . 3 . . . 4 . . . 5 . . . 6 . . . 7 . . . 8 . . .9 . . . 10 **Agree**	**Average response**	
	Students	**Teachers**
The program met or exceeded my expectations.	6.4	9.1
I felt that the take-home literature and materials were valuable.	6.2	8.0
The take-home Christmas-tree electronics project was challenging, but not too difficult.	7.3	8.6
The Robolab contest helped me understand the material from the Robolab training.	8.5	8.9
The robotics demonstration by the UMR students gave me an idea of how much can be learned as an engineering major.	7.9	9.0
A sufficient number of engineering professional assisted with the program activities.	7.1	8.3
I found that the invitation and the communications provided prior to the program prepared me for the experience.	7.6	8.6

electronics kit. The formal interaction opportunities at the luncheon and the banquet were also highly valued. The teacher ratings were generally higher than the student ratings. The plenary and poster sessions had the lowest ratings, but these components had the most variable ratings with some rating them low and some rating them very high. The ranking results show similar trends. The electronics kit activity had the highest average, closely followed by the robotics activity and the luncheon. The results for the other issues show high ratings with regard to program organization and administration.

The overall response to the program can be seen in the last question in Table 2 and the first question in Table 4. The individual interaction had high value, particularly for the teachers. This aspect was the third highest item for the teachers. The program also met or exceeded the expectations of the participants to a high degree. The teachers were especially pleased with the program, giving it their highest level of agreement in this part of the survey. Other yes-or-no questions (not shown in the tables) were included on the survey. All participants would 'recommend the experience to another high school student' and 'now have a better understanding of engineering.' A strong majority of the both teachers and students felt that the technical conference environment added to the pre-college activities. All of the teachers and most of the students stated that they had a significant one-on-one conversation with engineers. While most of the participants had been to an outreach program sponsored by an engineering university, a technical society, or the National Science Foundation, all but one student and all but three teachers had never been to a technical conference.

Post-reflective statements

A reflective statement was included on the following aspects.

1. Please describe how your participation in the GLOBECOM pre-college program has affected your knowledge of engineering, perception of engineers, and interest in engineering topics.
2. Please describe the importance of technical literacy (i.e. being well-informed regarding science, technology, engineering, and mathematics—STEM) for all students in society and please comment on:
   - (students) the personal relevance of STEM subjects for your future study and career plans;
   - (teachers) how engineering topics can be better incorporated into your classroom.

Many of the student comments reported that the experience had broadened their view of engineering, especially electrical and computer engineering. They better appreciated the scope of engineering work and the importance of engineering to everyday life. The teachers made similar observations and several teachers added that the conference illustrated the international involvement in technological development. Most students felt that the experience had given them useful career information. Several mentioned plans to pursue engineering studies and noted that the experience encouraged those plans. One student indicated that the conference helped her decide against engineering, but she also noted that the experience would be useful for her intended career in teaching. Most teachers stressed the importance of STEM education for their students and the usefulness of outreach programs. Several teachers expressed appreciation for the skill components involving robotics and soldering and discussed plans to incorporate ideas generated from the program.

Selected student comments are shown below:

> I did not know much about engineering before the pre-college program. I went to the program hoping to gain more information . . . I know now that not all engineers are the same and there is a wide range of engineering careers, I don't think that I will become an engineer. I would like to be a teacher.
>
> GLOBECOM helped finalize my career choice in electrical engineering.
>
> It showed me that engineering is more than just building houses.

Selected teacher comments are:

> I find that some students that excel in math and science shy away from technical careers. Programs such as yours give students an opportunity to see how valuable a technical career can be.
>
> I am better able to teach certain terms that I didn't know prior to the program.
>
> Attending the conference has broadened my understanding of the range of engineering topics and careers. . . . I found most of the people that I interacted with to be very personable and engaging.
>
> Pre-college programs that include teachers are one very valuable way of educating the educators, so that they in turn have the tools to stimulate the young minds of tomorrow.

In-school events

The student participants were required to present their conference experiences at their local schools per the invitation agreement. The guidelines for the presentation were as follows.

> *In-School Presentation*: The participating students and teachers should share the GLOBECOM experience with their schools through a presentation at least 20 minutes long. All participating students should be involved in the presentation. A suggested organization is (1) GLOBECOM Conference (description of the experience & conference highlights), (2) Program Activities (ROBOLAB Competition & Electronics Workshop), and (3) Perception of Engineering and Engineers (Engineering as a career, observations, & lessons learned). Feel free to change the organization and tailor the presentation to your school. A PowerPoint template and a CD of conference photographs are included as resources for your presentation.

The local school could choose a class period, a school assembly, or an after-school meeting for the presentation. All of these options were used in the partner schools. The presentations followed the guidelines and were seen by approximately 500 students. An example of one the presentation title pages is shown in Fig. 3.

The presentations revealed much about the perspective of the students toward engineering and how the conference-based program changed this perspective. One student commented on seeing the broader scope of engineering and another observed the excitement that engineers had for their career. These comments were fairly typical.

> Before I went I thought engineers were just people who built skyscrapers, but now I see they do so much more. Without engineers you would not have the Internet, there would not be robots or anything else electrical.

Fig. 3. Example page of an in-school presentation.

(The engineers had) a passion for their work. It would be nice to have a job that you want to get up for in the morning.

CONCLUSIONS

An outreach program was held at the GLOBECOM Conference for seventeen high school students and ten pre-college teachers. The program included dedicated pre-college activities and selected conference components and incorporated professional topics, provided exposure to engineering technologies, and introduced technical skills. The key aspect of the program was the use of an engineering conference environment. This environment provided varied opportunities for the pre-college participants to interact with engineering professionals and to gain insight into engineering careers and technologies. The in-school follow-up presentations expanded the reach of the program.

The effectiveness of one-on-one interaction among teachers, high school students, engineering students, and working engineers was evaluated. Both students and teachers reported significant interactions while at the conference and felt that the overall experience was valuable. Also, formal interaction components such as the luncheon were highly rated. The appropriateness of the various conference program components was also evaluated. While the dedicated activities received the highest ratings and the level of the conference components caused some difficulty, combination of dedicated and conference components seemed to generally work well. Most of the participants commented on beneficial aspects of the conference environment.

A principal benefit of the experience was improving the participant perceptions of engineering work. The program, and the conference environment in particular, seemed to show the scope of engineering and the everyday relevance of engineering work. The global nature of technological development was also emphasized. The students generally gained information related to their career choices and the teachers gained insight into STEM topics and career options [12].

An understanding of what conference components are appropriate for pre-college teachers and students will encourage similar activities in future conferences. Again, the dedicated components, especially the hands-on and personal interactions, should be emphasized. By starting the program with an interactive robotics experience, the teachers and high school students overcame anxiety or nervousness about the program. The electronics kit gave them a take-home item. The selected conference events should minimize the technical details and emphasize the professional and career aspects of engineering. The focus on professional issues rather than technical skills or college pre-orientation complements other pre-college outreach opportunities [13, 14].

The organization of the pre-college program benefited from having multiple engineering educators and college students assist with various activities. Prior knowledge of the backgrounds of the teachers and the student participants is needed to appropriately plan the activities. Support by the conference committee greatly facilitated the involvement of the participants in the selected conference activities. The IEEE Communications Society committee and staff were impressed with the program and encouraged similar programs for future conferences.

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REFERENCES

1. L. J. Genalo, M. Gallagher, and J. Golder, An engineering linkage to K-12 teachers, *Proceedings of the 2001 ASEE Annual Conference*, Albuquerque, NM, (2001).
2. T. R. Rhoads, S. E. Walden, and B. A. Winter, Sooner elementary engineering and science—A model for after-school science clubs based on university and K-5 partnership, *J. of STEM Education*, **5**(3/4), 2004, pp. 47–52, Available: www: http://www.jstem.org/.
3. L. J. Bottomley and E. A. Parry, Beyond the classroom walls: Relating science to children's everyday lives, *Proceedings of the 2003 ASEE Annual Conference*, St. Louis, MO, (2000).
4. P. C. Lam, T. Srivatsan, D. Doverspike, J. Vesalo, and P. R. Mawasha, A ten-year assessment of the pre-engineering program for under-represented, low incomeand/or first generation college students at the University of Akron, *J. of STEM Education*, **6**(3/4), (2005) pp. 14–20, Available: www: http://www.jstem.org/.
5. P. C. Wankat, Survey of K-12 engineering-oriented student competitions, *International Journal of Engineering Education*, **23**(1), 2007, pp. 73–83.
6. T. M. Swift, S. E. Watkins, K. Swenson, E. Lasater, and O. R. Mitchell, Involving engineering with in-service K-4 Teachers, *Proceedings of the 2003 ASEE Annual Conference*, Nashville, TN, (2003).
7. IEEE Communications Society, *GLOBECOM Global Communications Conference*, 2008. Available: www: http://www.comsoc.org/confs/globecom/.
8. R. Hixon, S. E. Watkins, S. J. Bentley, and M. A. Huggans, Student robotics competition using Robolab and Lego Bricks, *Proceedings of the 2006 Midwest Section Conference of the ASEE*, Kansas City, MO, (2006).

9. R. Hixon, Teaching software principles using Robolab and Lego Mindstorms, *International Journal of Engineering Education*, **23**(5), 2007, pp. 868–873.
10. LEGO Education, LEGO Education, 2008. Available: www: http://www.legoeducation.com/.
11. T. M. Swift and S. E. Watkins, An engineering primer for outreach to K-4 education, *J. of STEM Education*, **5**(3/4), 2004, pp. 67–76. Available: WWW: http://www.jstem.org/.
12. T. Lewis, Engineering education in schools, *International Journal of Engineering Education*, **23**(5), 2007, pp. 843–852.
13. B. E. Lorenz, Bringing 'Engineering Forward' to the high school: One university's experience in starting an engineering summer camp, *Proceedings of the 2004 Frontiers in Education Conference*, Savannah, GA, (2004).
14. M. K. Thompson and T. R. Consi, Engineering outreach through college pre-orientation programs: MIT discover engineering, *J. of STEM Education*, **8**(3/4), 2007, pp. 75–82. Available: www: http://www.jstem.org/.

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