NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP Report 347-PART II

Civil Engineering Careers: A User's Guide for Awareness, Retention, and Curriculum Programs

Transportation Research Board
National Research Council

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Report 347-PART II

Civil Engineering Careers: A User's Guide for Awareness, Retention, and Curriculum Programs

J.M. MASON, JR., and L.M. KOSTIVAL The Pennsylvania Transportation Institute The Pennsylvania State University University Park, PA

Subject Areas

Planning and Administration Aviation Public Transit Rail

Research Sponsored by the American Association of State Highway and Transportation Officials in Cooperation with the Federal Highway Administration

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

Note: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers names appear herein solely because they are considered essential to the object of this report.

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The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation officials, or the Federal Highway Administration, U.S. Department of Transportation.

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FOREWORD

By Staff Transportation Research Board The User's Guide contained herein details strategies for implementing various programs to provide students with an awareness of civil and transportation engineering careers, to retain students who have the interest, and to affect curriculums that relate the relevance of class material to such careers. These programs have been referred to as the ARC (Awareness, Retention, and Curriculum) model. The Guide supplements previously published NCHRP Report 347, "Civil Engineering Careers: Awareness, Retention, and Curriculum," which documented the first phases of a three-phase NCHRP project and, in general terms, suggested the ARC model. This Guide, i.e., NCHRP Report 347-Part II, covers the third phase designed to expand the ARC model. An agency report is available also that includes a number of other existing programs and services, catalogued in terms of the ARC model. The Directory of Programs and Services has been distributed to NCHRP sponsors with this User's Guide and is available to others on request.

The overall objective of NCHRP Project 20-24(3), "Expanding the Civil Engineering Pool," conducted by the Pennsylvania Transportation Institute (PTI), grew to include recommendations on various implementable actions that will improve not only the number of civil engineers interested in transportation careers, but also the quality of those engineers and the recognition of the increasingly diverse demographics of our population.

Under the first phase, PTI catalogued and described existing techniques that are now being used to promote among students an awareness of civil engineering career options as well as those techniques that provide an awareness for mathematics and science studies. Programs designed to improve upon employee shortages in other professions were studied to benefit from any similarities in the problem and subsequent solutions. Also under this phase, 17 focus groups at 4 locations were conducted with students, teachers, parents, and counselors to gain insight into attitudes on civil engineering as a profession and career option.

Under the second phase and based on the results of Phase I, PTI recommended a series of actions that span kindergarten through college. Acknowledging that other programs promote mathematics and science, the degree to which these recommended actions stress civil engineering as a career option increases as the level of education increases. These various actions have been categorized under three themes: Awareness, Retention, and Curriculum, and are now referred to as the ARC model. The results of Phases I and II were published as NCHRP Report 347, "Civil Engineering Careers: Awareness, Retention, and Curriculum."

Under a third and final phase, PTI produced this user's guide for implementing the ARC model and a *Directory of Programs and Services* categorized by the various ARC components. The *Directory* will be provided to all state DOTs and to others on a loan basis or for purchase (\$15.00). Contact the NCHRP, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

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ACKNOWLEDGMENTS

This report was prepared by the Pennsylvania Transportation Institute (PTI), The Pennsylvania State University, as partial fulfillment of NCHRP Project 20-24(3), "Expanding the Civil Engineering Pool." Dr. John M. Mason, Jr., director of the Transportation Operations Program at PTI and professor of civil engineering, served as principal investigator. The other principal author of this publication was Ms. Lynn M. Kostival, graduate research assistant at PTI.

For Phases I and II of this project, The Brand Consulting Group, Southfield, MI, served as the subcontractor that performed the market research study. Mr. Jonathan Brand and Mr. Milton Brand conducted the focus group sessions. For Phase III of the project, The Brand Consulting Group also reviewed the draft reports of this publication.

Other project team members who provided significant guidance, review, and assistance throughout the Phase III research effort include several

members of the faculty and administration at Penn State: Dr. Peter B. Everett, associate professor of marketing; Dr. Edwin L. Herr, associate dean, Academic Programs and Research, College of Education; and Ms. Sharon Jadrnak Luck, director, Women in Engineering Program. Their expertise and insight helped to establish the central issues of awareness, retention, and curriculum as the focal strategies of future efforts to enhance the civil engineering pool.

The authors wish to thank the support staff of PTI for their diligent efforts and assistance in producing this report. Special appreciation is also extended to the telephone interview participants at the various state transportation agencies, academic institutions, professional societies, and other organizations that provided specific information to be compiled in this document.

CIVIL ENGINEERING CAREERS: A USER'S GUIDE FOR AWARENESS, RETENTION, AND CURRICULUM PROGRAMS

SUMMARY

The facts and trends affecting entry into the civil engineering profession require all concerned with the supply of high-quality civil engineering services to society to rethink promotion of the profession. Two key trends have developed: white males (the traditional supply of civil engineers) will reportedly constitute only 15 percent of the *net* new workers coming into the labor pool through the end of the century, and ethnic minorities and women will be the largest addition to the labor pool. Ethnic minorities and women are significantly underrepresented in civil engineering. Furthermore, the retention rate of ethnic minority students entering the study of civil engineering is poor. Compounding the situation, the fastest growing sectors of the nation's work force will also be competing for individuals with the highest skill levels.

The overall scope of NCHRP Project 20-24(3) includes the identification, development, and testing of specific actions that will increase the quality and diversity of the future supply of civil engineers available to transportation-related agencies.

The research activities of NCHRP 20-24(3) were conducted in three phases. Phase I identified the attitudes and expectations of various parties involved in career-choice decisions. It also documented practices used by transportation agencies, universities, and other professional disciplines to increase interest in civil-engineering-related careers. Phase II of the project used these findings to prepare candidate action plans for increasing the supply of civil engineers. The goal, objectives, target audience, essential and supportive elements, implementation concerns, and justification for each action plan were identified in NCHRP Report 347. These various actions have been categorized under three themes: Awareness, Retention, and Curriculum, and are now referred to as the "ARC Model." The ARC Model contains three comprehensive and interrelated marketing strategies:

- 1. Heighten the Awareness of the civil engineering profession.
- Improve the Retention rate of the existing pool of potential civil engineering candidates.
 - 3. Enhance the Curriculum of pre-college and college programs.

Phase III advances particular actions in the ARC Model by incorporating more specific instructions as to how various constituencies can implement the identified action plans.

This User's Guide serves as a single-source document that provides a permanent reference for securing information and guidance available to agencies and organizations interested in enhancing the civil engineering and transportation profession. It complements the recruitment and retention initiatives of the American Association of State Highway Transportation Officials (AASHTO) and the investment of several other constituencies in the TRansportation And Civil engineering (TRAC) activities and materials.

This report, titled Civil Engineering Careers: A User's Guide for Awareness, Retention, and Curriculum Programs, concludes Phase III. It contains 14 sections that provide step-by-step descriptions of how various constituencies can implement the action plans of the ARC Model.

A Directory of Programs and Services, which is available as a separate document from NCHRP, has been produced in conjunction with the User's Guide. The Directory contains existing activities of federal/state agencies, professional groups, private/public sector groups, and educational institutions designed to recruit and retain students (at various developmental stages) in the mathematics/science, technology, engineering, or civil engineering areas. Each Directory listing includes the program name, a one-sentence description of the program, and the program address, phone number, and contact person.

CHAPTER 1

INTRODUCTION

PROBLEM STATEMENT

The facts and trends affecting entry into the civil engineering profession require all concerned with the supply of high-quality civil engineering services to society to rethink promotion of the profession. Two key trends have developed: white males (the traditional supply of civil engineers) will constitute only 15 percent of the net new workers coming into the labor pool through the end of the century, and ethnic minorities and women will be the largest addition to the labor pool. Ethnic minorities and women are greatly underrepresented in civil engineering. Furthermore, the retention rate of ethnic minority students entering the study of civil engineering is poor. Compounding the situation, the fastest growing sectors of the future work force will be those requiring the highest skill levels. These sectors include lawyers, natural scientists, and engineers. More than one-half of the new jobs will be filled by college graduates.

From 1980 to 1989, the percentage of women conferred civil engineering degrees increased from 9 percent of all civil engineering degrees to 14 percent. During this same period, the percentage of African Americans conferred civil engineering degrees has remained constant, and the representations of Hispanic Americans and Asian Americans have shown modest increases (1). However, women and minorities remain underrepresented relative to their numbers in the population. The Office of Technology Assessment (OTA) attributes this underrepresentation to the following seven factors (2):

- 1. The legacy of discrimination toward women and minorities.
- 2. Differential treatment applied on the job, especially toward women.
- 3. The lack of early educational opportunities for minorities, especially due to economic, social, and cultural factors.
- 4. Female socialization patterns that discourage women from pursing engineering as a career.
- 5. The continuing expectation that women will continue to assume the major role in housekeeping and child rearing.
 - 6. The lack of financial support for minorities.
 - 7. The lack of role models and early exposure.

PROJECT OBJECTIVE

The overall scope of NCHRP 20-24(3) included the identification, development, and testing of specific actions that would increase the quality and diversity of the future supply of civil engineers available to transportation-related agencies. Particular attention and emphasis have been placed on the implications of changing demographics on the future work force.

RESEARCH APPROACH

The research to expanding the civil engineering pool was comprised of three phases. Table 1 contains an annotated outline of the key elements of each phase.

MARKET RESEARCH STUDY

The principal means of field data collection in Phase I was a market research study designed to determine how people make career-choice decisions and what underlying attitudes and perceptions they have about civil engineering and other professions. A qualitative research method known as the "depth group" or "focus group" was used. The study was conducted by The Brand Consulting Group, Southfield, MI, and coordinated by the Penn State study team, with assistance from the study consultants located at the field data-collection sites.

A total of 17 focus group sessions were conducted in 5 locations. Selected groups consisted entirely of African-American or Hispanic-American subjects, while the balance were ethnically mixed (although predominantly Caucasian). All groups contained a mix of male and female participants.

Phase I identified several fundamental obstacles facing the civil engineering profession in general, and the future pipeline of entrants:

- 1. An image problem exists for the civil engineering profession.
- 2. Institutional barriers exist that contribute to increasing attrition rates among high school and college students.
- 3. Changes are necessary in pre-college and college curricula if enhancements are to be made in mitigating items 1 and 2 above.

THE ARC MODEL

As a result of the Phase I research, the $\underline{\mathbf{A}}$ wareness, $\underline{\mathbf{R}}$ etention, and $\underline{\mathbf{C}}$ urriculum (ARC) Model was developed as a recommended course of action to enhance the pool of civil engineers. Three interrelated market strategies targeting different developmental stages of the potential future civil engineer were developed:

- 1. Heighten the **Awareness** of technology, engineering, and civil engineering.
- 2. Increase the **Retention** of the existing pool of future civil engineers.

Phase I. Data Gathering

- Document practices used by undergraduate civil engineering and engineering technology programs, and state transportation agencies to increase interest in civil engineering and related careers.
- Document practices used by other professional disciplines to address their labor shortages.
- Identify the attitudes and expectations of various parties involved in civil engineering careerchoice decisions, by means of a market research study.
- Prepare an interim report that serves as a catalog of current practices and summarize the early findings of the market research.

Phase II. Prepare Implementation Actions Plans

- Convene entire project team to review interim findings and identify candidate action plans.
- Prepare candidate action plans for increasing the supply of civil engineers.
- Prepare a comprehensive research report on Phase I and II activities.

Phase III. Produce Manual of Selected Techniques

- Develop, test, and refine selected actions.
- Produce manual of selected actions.

Market Strategies	DEVELOPMENTAL STAGES					
	Pre-College (grade level)			College (year of study)		
	K-6	7-8-9	10-11-12	1-2	3-4	
AWARENESS	The Environment	The ⇒ Engineer ⇒	The Civil Engineer	Intro to Civil Engr. Disciplines	Summer/ ⇒ Co-op Employment	
RETENTION	Field Trips =	Profession Note:	Peer Mentors	Clustering	⇒ Professional Mentors	
CURRICULUM	Technology Applications	Mathematics and Sci	ence Emphasis	Introduction to Design	⇒ Project Design	

Figure 1. ARC model.

3. Modify the existing Curriculum from kindergarten through college.

Figure 1 illustrates the organization of the conceptual model and identifies the specific strategies of the ARC Model.

The ARC Model argues that to successfully enhance the civil engineering pipeline, future marketing strategies must consider awareness, retention, and curriculum issues in the development of individual action plans. Specific objectives must likewise be defined at each developmental stage of the model for the pool of potential engineers.

As one proceeds through the developmental stages, a selected objective becomes more narrowly defined (from global engineering to civil engineering to the specialties of civil engineering). Similarly, as one proceeds from the awareness strategy to the retention strategy to the curriculum strategy, the target audience also narrows.

Awareness strategies target both the potential pool and the influencers (parents, teachers, counselors, and practicing professionals). The retention strategies tend to be more personalized. Curriculum strategies intimately affect the students (and teachers).

RECOMMENDED PHASE II ACTION PLANS

Fifteen candidate action plans were developed in Phase II of the research to address specific issues at each defined developmental stage. The goal of each recommended action plan is cited in Figure 2. If the ARC Model were fully implemented, the awareness, retention, and curriculum strategies applied at the pre-college developmental stages should reduce the need for the college actions.

PHASE III ACTIVITIES

The principal means of field data collection in Phase III were telephone interviews with established programs. These interviews were designed to gather specific details regarding implementation issues of the existing programs. A total of 21 interviews were conducted with professional engineering societies, State DOTs, and universities. A great deal of variation existed between the types of programs, age groups, and objectives of the contacted programs.

Market Strategies		Pre-College	University		
	Elementary (Grades K-6)	Junior High (Grades 7-8-9)	Senior High (Grades 10-11-12)	Engineering/Non- Engineering Students (Freshman/Sophomore)	Civil Engineering Students (Junior/Senior)
AWARENESS	ARC-1 Discuss technology and global engineering.	ARC-4 Present engineering as a career alternative with an introduction to civil engineering.	ARC-7 Provide civil engineering career information.	ARC-10 Provide engineering career information to: • Civil engineering students • Students in other majors • Students at other institutions	ARC-13 Provide information regarding the disciplines within civil engineering.
RETENTION	ARC-2 Build confidence in mathematics and science.	ARC-5 Maintain confidence in mathematics and science.	ARC-8 Promote and retain technical interest.	ARC-11 Retain and graduate civil engineering students.	ARC-14 Retain and graduate engineering students.
Curriculum	ARC-3 Integrate early relevancy of mathematics and science.	ARC-6 Encourage further pursuit of mathematics and science.	ARC-9 Complete mathematics and science requirements.	ARC-12 Integrate early exposure to engineering/civil engineering disciplines.	ARC-15 Integrate design projects (collaborative learning) into the curriculum.

Figure 2. Goals of the candidate action plans.

The following list of organizations and programs were interviewed:

American Chemical Society—Chemistry Olympiad American Chemical Society-Pre-High School Science American Society of Civil Engineers—Recruitment Programs CALTRANS—Adopt-A-School Institute of Transportation Engineers-Outreach Program Junior Engineering Technical Society-"TEAMS" Competition Math/Science Network—Expanding Your Horizon Conferences Michigan DOT-Aim for Civil Engineering Program National Society of Professional Engineers-Discover "E" National Society of Professional Engineers-MATHCOUNTS Penn State University-Ms. Wiz Penn State University-Summer Space Academy PRIME, Inc.—Intervention Programs Rockwell International—Education Motivation Program Rockwell International—Youth Motivation Program SAE International-A World in Motion Society for Mining, Metallurgy, and Exploration, Inc.-Mineral Information Institute Society of Hispanic Professional Engineers—Advancing Careers in Engineering Texas DOT-Grants for Minorities Texas DOT-Texas Alliance for Minorities in Engineering University of California, Berkeley-Family Math

USER'S GUIDE

The culmination of Phase III of NCHRP Project 20-24(3) is this *User's Guide*, which was designed to assist a broad-based constituency in implementing the ARC action plans (see Figure 3). This document provides a step-by-step description of how various constituencies can actually proceed with the implementation of identified action plans. It serves as the single document that provides the "permanent literature" function for securing information and guidance available to agencies and organizations

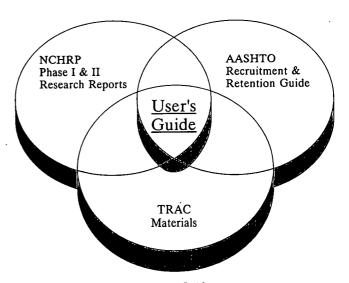


Figure 3. Function of the User's Guide.

interested in enhancing the civil engineering and transportation profession. The *User's Guide* complements the recruitment and retention initiatives of American Association of State Highway and Transportation Officials (AASHTO) and the investment of several other constituencies of the <u>TRansportation And Civil engineering</u> (TRAC) activities and materials.

A Directory of Programs and Services, which is available as a separate document from NCHRP, has been produced in conjunction with the User's Guide. It contains existing activities of federal/state agencies, professional groups, private/public sector groups, and educational institutions designed to recruit and retain students (at various developmental stages) in the mathematics/science, technology, engineering, or civil engineering areas. Each Directory listing includes the program name, a one-sentence description of the program, and the program address, phone number, and contact person.

CHAPTER 2

INSTRUCTIONS FOR USING THIS MANUAL

The User's Guide is arranged according to the three program elements of the ARC Model: Awareness Programs, Retention Programs, and Curriculum Programs. Fourteen specific action plans have been identified and are presented as one of the respective ARC Model element(s). Each action plan has been prepared as a stand-alone document. For example, all of the steps and information necessary to implement a school presentation program are provided in the "School Presentation" section under Awareness Programs. The various sections of the User's Guide contain some repetition of information because it is anticipated that individual actions may be implemented without reference to other action plans. As such, the action plans of the User's Guide do not have to be read or applied in any particular sequence.

Each action plan contains an identifying header running along the top of every page. The three boxes contained in the header illustrate whether the action plan is classified as awareness, retention, or curriculum. The ARC target audience of the action plan is listed on the first page of each program section. The first page of each action plan also provides a brief description of the program and an estimate of the resources (time, money, personnel) required to institute each type of program.

The remainder of each action plan recommends a series of "steps" to implement a particular program. A banner running down the right side of each page identifies the step and depicts the range of associated discussion. Helpful hints about each program are presented in shaded boxes interspersed throughout the steps of each section. Occasionally, caution statements (accompanied by a diamond symbol) are provided to alert the reader to possible obstacles or problems with program implementation that have been experienced by established programs.

References to other sections of this manual or other documents, where appropriate, are provided in shaded boxes. The end of each program section of the *User's Guide* contains specific references to the *Directory of Programs and Services*. The Directory contains existing services and programs reported by various federal/state agencies, professional groups, public/private sector groups, and educational institutions to recruit and retain students (at various developmental stages) to the mathematics/science, technology, engineering, or civil engineering areas.

NOTES ABOUT SELECTED ACTION PLAN STEPS

This section contains several comments about selected steps presented in the various programs of the *User's Guide*.

Form a Committee

The first step in many of the program sections is "Form a Committee." This step is optional and depends upon the size of

the planned program and the agency implementing the program. For larger awareness, retention, and curriculum programs, many established programs suggest forming a committee for a number of reasons. The main reason is that forming a committee is an excellent way to gather a diverse group of people to gain their input and expertise in designing a successful program. A committee can also help divide the responsibilities of implementing a new program among several smaller subcommittees. Tasks such as recruiting volunteers and corporate sponsors, developing competition rules, or marketing the program can be delegated to subcommittees rather than having two or three people do all of the tasks.

For programs that are smaller in scope, forming a large committee is not necessary when two to three people can implement a particular program. An example of a program not requiring a full-fledged committee is a School Presentation program targeting only one or two schools.

Determine a Target Audience

An important step in implementing a new program is choosing the target audience. In most action plans of this publication, this step is included in "Form a Committee." Determining a target audience for a program should be one of the first tasks that a committee or program director undertakes, because the audience chosen will affect the goals and design of the entire program. Grade level, ethnicity, gender, interest in mathematics and science, and grade point average are just some of the considerations in choosing a target audience. The Phase I market research has revealed that actions to implement the ARC strategies must vary with respect to the developmental stages of the target audience.

The attributes of the various developmental stages as presented in *NCHRP Report 347* are briefly provided in the following sections. These attributes give an indication of the different issues that need to be addressed in programs for each target audience (3).

The Early Years (K-6)

It is widely acknowledged that children begin to formulate career impressions at a relatively young age. They acquire opinions of the work people do, the kind of people employed in various occupations, the compensations offered, and the abilities required for acceptable performance. On the basis of these impressions, they enthusiastically embrace some occupations as possible careers for themselves and absolutely remove others from present or future consideration. Accordingly, presenting

children (along with parents, teachers, and counselors) with positive images and impressions about general (i.e., global) engineering may begin at the elementary level. Capturing their awareness of how engineering relates to the needs and functions of society (early relevancy), of the interrelationship of work and learning, and of the importance of educational achievement to opportunities in an engineering career (along with building confidence) are among the first steps toward increasing technological awareness.

Junior High (7-8-9)

This level is a transition period between general and specialized education. Exploration and planning are important for students (and parents) at this level. Timely, relevant, and accurate information about engineering with an introduction to civil engineering may be introduced at this time. Through this awareness and exploration of engineering, answers can be offered regarding (1) the amount and type of education needed for entrance; (2) the content, tools, settings, products, or services with which engineering is associated; (3) the potential of such an occupation to satisfy personal interests; and (4) the potential of such an occupation to provide the type of lifestyle desired. With such answers, planning (and relevant course choices) for the next education level will start at the appropriate time. Keeping in mind the continuing need to instill confidence and the relevancy of mathematics and science is essential.

Senior High (10-11-12)

Providing students (and parents) with specific career information regarding civil engineering and its specialties continues through the senior high school level. It is at this stage where career choice—real or perceived—takes place. Technical interest must be maintained. Preparatory classes to pursue undergraduate work must be completed. Role model and mentoring activities, coupled with summer employment opportunities, workshops, use of information systems, and participation in intervention programs contribute to the retention of the student's interest.

College

Engineering freshmen with undecided majors, students in other scientific colleges, and students in junior college and vocational-technical schools could be motivated to investigate and pursue civil engineering if made aware of civil engineering. Junior college and vocational-technical students are individuals that traditionally have not entered the civil engineering pipeline. Returning adults is another group to be considered. It should also be recognized that many students' decisions at the undergraduate level may well be short-term compromises. As such, the importance of continual professional development must therefore be instilled in the graduate.

CHAPTER 3

AWARENESS PROGRAMS

As stated in NCHRP Report 347 (Part 1), images are recruiting mechanisms. The research from Phase I of the project showed that civil engineering has a poorly defined image among students (the pipeline) and their adult advisors (influencers). Image responses that are nonexistent, unflattering, or inaccurate are reasons for dismay. Furthermore, engineering, in general, was found to be seriously misunderstood. A large number of engineering students in the focus groups stated that they had no comprehension of the engineering profession when they entered engineering school. Accurate, timely, and relevant information must be provided to students at all developmental levels and their influencers (3).

The seven Awareness Programs contained in this User's

Guide, with the exception of Career Fairs, are applicable to students in grades K-12 and college. Career fairs are geared toward older students in grades 7-12 and college. Some strategies for the involvement of engineers and transportation professionals in Awareness Programs include: making classroom presentations about the field of engineering, distributing printed guidance material and videos about engineering, attending career fairs to answer questions about engineering, and holding field trips and open houses to interest students in engineering. All of these awareness strategies help engineers and transportation professionals heighten the awareness of technology, engineering, and civil engineering among K-12 students and college students.

RETENTION

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ACTION PLAN: AWARENESS PROGRAMS FOR ELEMENTARY SCHOOL STUDENTS

ARC Target Audience

• Elementary (K-6)

What are Awareness Programs for Elementary School Students?

Awareness Programs in this manual refer to school presentations given by engineers to elementary school classes. Research has found that presenting children with positive images and impressions about general (i.e., global) engineering may begin at the elementary level (1). These programs need to demonstrate how engineering relates to society and the importance of studying math and science. Distributing coloring books about engineering or school supplies with an engineering agency's logo to students during the presentation helps to generate a sense of excitement about engineering.

What are the resources necessary to begin?

Time:

Depending on the size of one's program and the activities planned, about 1 month will be needed to plan and develop the awareness program.

Money:

Since volunteers will be recruited from within one's agency to give presentations in schools, expenditures for awareness programs will be minimal. Expenses will be primarily for hands-on activities or printing school supplies with the agency's logo.

Related Resources:

1. One person from the agency should be appointed as program director to coordinate the awareness program.

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- 2. A minimum of two engineers should be recruited as volunteers. Most established programs suggest sending pairs of engineers into schools to make presentations. If the program is especially targeting women and minority students, it will be important to have women and minority engineer role models.
- 3. A commitment to participate in the program should be obtained from at least two teachers in the targeted school. This is especially crucial for the elementary level, since volunteer engineers should work closely with teachers to develop their school presentations.

Implementation:

Follow the set of steps below for developing awareness programs for elementary school children. The *Directory of Programs and Services* contains a list of awareness programs for elementary school students to contact for more information to help make your program a success!

Design a Presentation

The main goals of an elementary school presentation should be to introduce students to the field of engineering and to generate enthusiasm about studying mathematics and science. Each team of two engineers will be responsible for designing their own classroom presentation. The team should work very closely with the teacher of the class to which they will be speaking. An elementary teacher can give valuable input as to what should or should not be included in the presentation. For example, the teacher can advise the volunteer engineers if the activities they have planned are too advanced for the targeted grade level. The teacher can also tell the engineers what types of questions to expect from the students and how long to make the presentation.

Some established programs have developed videos and written material to help prepare engineers and scientists to visit and interact with elementary classroom students. For more information, contact:

Chemists in the Classroom

American Chemical Society Pre-High School Division 1155 16th Street, NW Washington, DC 20036

Awareness

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Sharing Science with Children: A Survival Guide for Scientists and Engineers

American Association for the Advancement of Science (AAAS) 1333 H Street, NW Washington, DC 20005-4792 STEP
1
(Cont.)

Short hands-on activities will make the presentation more interesting to students. Hands-on activities are designed for students to work individually or in groups to stimulate the students' interest in scientific or technical areas. These activities provide students with an experience as well as an awareness of how mathematics relates to the outside world. Hands-on activities generally take more time than an ordinary presentation. For this reason, be sure to inform the classroom teacher *before* the presentation about any hands-on activities that will be included in the presentation.

It is not necessary to invent one's own hands-on activities. Many established programs listed in the *Directory of Programs and Services* (e.g., Discover "E," Expanding Your Horizon Conferences) have kits with ideas for hands-on activities that can be conducted in the classroom.

Distributing engineering coloring books, book marks, or school supplies at the end of the presentation will help students remember the presentation.

Contact Schools

The next step to implementing an awareness program is to contact schools and let them know one's agency is interested in speaking to their elementary students. A commitment to participate in the program should be obtained from at least two teachers in the targeted school. This is especially crucial for the elementary level, since volunteer engineers should work closely with teachers to develop their school presentation.

Most successful established programs suggest starting out the first year by only having one or two schools participate in the program. This will keep one's awareness program small and manageable and give the volunteers a chance to refine their program presentations. Following the first few school presentations it should be easy to identify the parts of the program that are working and the parts that need revising.

RETENTION

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Some things to consider when contacting schools include

- Student grade level,
- Student interest in mathematics and science, and
- Student ethnicity.

Recruit Volunteers to Make Presentations

The number of volunteers that will need to be recruited depends on the number of contacted schools interested in one's program. However, most established programs recommend sending volunteer pairs of engineers into schools to make presentations. With two engineers present, the engineers feel more comfortable and the presentations are more interesting to school children.

Ideally, the engineers chosen from one's agency as volunteers should be professional, friendly people who are enthusiastic about the field of engineering. They should also possess good communication skills and be comfortable around young children.

Some established programs have had problems recruiting volunteers during initial program development without offering incentives. However, awareness programs for elementary students are generally very short presentations lasting no more than 1 or 2 hours in the classroom. Even preparing the presentation takes a very short amount of time (several hours at the most). Most program directors stress that personal contact is the key to getting people to volunteer for one's program without other incentives.

Following is an additional idea to encourage volunteers:

• Time off during normal work hours to make school presentations.

Implement, Then Evaluate the Program

Even though the target audience of one's presentation is elementary school children, the program should still be evaluated to assess the overall impact of the presentations.

The easiest way to evaluate this type of program is to simply ask students three or four questions at the end of the presentation. Example questions include: What did you like about the presentation? What didn't you like? and so on. Keep this session brief and remember the age of the school children when phrasing the questions.

STEP 2

(Cont.)

STEP 3

RETENTION

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The program director should also formulate and distribute questionnaires to teachers and volunteer engineers to assess their opinions about the awareness program.

STEP 4 (Cont.)

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Awareness Programs for Elementary School Children," have successful elementary awareness programs. They can be contacted for more information, help, or ideas.

RETENTION

CURRICULUM

ACTION PLAN: CAREER FAIRS

ARC Target Audiences:

- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)

What are Career Fairs?

Career fairs are a chance for established professionals to visit schools and provide students with information regarding careers in civil engineering. It is also a chance for civil engineering faculty from universities to provide details about college engineering curricula for school students.

What are the resources necessary to begin?

Time:

In general, it should take very little time (under 1 month) or planning to become involved in a career fair.

Money:

Since career fairs only last 1 or 2 days and the agency will recruit volunteers from its personnel to staff the display and answer questions, expenditures for career fairs will be minimal. If necessary, the updating and printing of the agency's recruiting materials (brochures, posters, displays, etc.) will be the agency's primary expense.

Related Resources:

- 1. There will need to be one person from the agency appointed to coordinate the career fair presentation. This person should contact local schools, recruit volunteers within the agency, and evaluate existing recruiting materials (brochures, posters, etc.).
- 2. Several volunteers (two or three) will also be needed to staff the display and answer questions.

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Implementation:

Follow the set of steps below for developing career fairs. The *Directory of Programs and Services* contains a list of career fairs to contact for more information to help make your program a success!

Select the Target Audience for the Program

The first step in designing a career fair program is to select a target audience of students. The target audience of the program will influence the type of presentation and the printed guidance material used during the career fair. For example, a coloring book about the engineering profession would be inappropriate at a junior high school career fair. Also, employers at college career fairs emphasize the job opportunities and benefits within their company to try and interest graduating engineers in a full-time job. However, employers at junior high school career fairs try to interest students in pursuing a career in engineering.

Career fairs can target any student group from junior high school to college. Some things to consider when deciding upon a target audience include

- Student grade level,
- Student interest in mathematics and science.
- Student ethnicity and gender, and
- Student grade-point average.

Contact Schools

Most junior and senior high schools and universities have at least one career fair per year. During Step 1, contact local schools and universities and let them know the agency is interested in participating in their school's career fair.

For more information about contacting schools:

See p. 41 of "School Presentations"

STEP 1

RETENTION

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Evaluate Existing Recruiting Materials

STEP 3

Take some time before attending a school or university career fair to review the agency's career information (brochures, videos, posters, displays). The best way to do this is to solicit opinions about the literature from several people in one's department. Get together a group of three or four engineers who work for the agency and have recently graduated from college (4). Remember to include women and ethnic minorities in this group. Next, solicit the group's opinion regarding the agency's existing recruiting materials.



Remember the target audience when evaluating the printed materials.

As stated in NCHRP Report 347, keep in mind that the information must be accurate (current) and provide the following (3):

- Definition of civil engineering and its subdiscipline areas;
- Salary structure (short-term and long-term ranges);
- ⇒ Working environment (office and field);
- Advancement potential (managerial, technical, entrepreneurial opportunities); and
- ⇒ Education requirements.

For more information about evaluating existing guidance material:

See p. 33 of "Printed Guidance Material."
See Chapter 2 of the AASHTO Recruitment and Retention Guide.

Recruit Volunteers to Participate in Career Days

Ideally, your volunteers should be professional, friendly people who have worked for the agency for several years. Try to encourage women and minority engineers in the agency to volunteer to participate as role models. Since the amount of time to volunteer is minimal, it should be relatively easy to recruit enough volunteers to staff the display.

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For ideas to encourage participation:

See Chapter 4, p. 16, of the AASHTO Recruitment and Retention Guide.

STEP 4 (Cont.)

STEP 5

Implement, Then Evaluate the Program

Why is evaluation so important?

There are several reasons why evaluation is critical to the program's success:

- The overall impact of the program can be assessed.
- The effectiveness of the volunteers can be evaluated.
- The impact of the printed career information (brochures, posters, displays) can be assessed.

For more information about program evaluation developed by the U.S. Department of Education (5):

See p. 62 of "Mentoring Programs"

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Career Fairs," have successful career fair programs. They can be contacted for more information, help, or ideas.

See Chapter 6 of the AASHTO Recruitment and Retention Guide

RETENTION

CURRICULUM

ACTION PLAN: CONFERENCES

ARC Target Audiences:

- Elementary (K-6)
- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)

What are Conferences?

Conferences give groups of students the opportunity to meet engineering role models, gain career information about the field of engineering, and participate in hands-on mathematics and science activities. Conferences are defined by the activities they aim to address. For example, career conferences are characterized by resume and interview workshops. A common component of many engineering-related conferences is to stress the importance of mathematics and science.

What are the resources necessary to begin?

Time:

Depending on the size of the program and activities planned, a minimum of 5 to 8 months will be needed to plan and develop the conference.

Money:

The budget needed for the conference will depend on the size and scope of the conference as well as the resources that are available. For example, the greatest budgetary expense will be renting a facility in which to hold the conference. If there is a way to have the facility donated, the conference expenditures can be greatly reduced. Another significant expense incurred by the conference will be materials needed for hands-on activities and lunch for the participants (optional). Established programs estimate the total cost of a conference to be between \$3,000 and \$4,000.

Related Resources:

- 1. A committee of at least six or seven people will be needed to design the conference.
- 2. One person from this committee must be appointed to serve as program director.

RETENTION

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3. It will also be necessary to recruit volunteer conference speakers and role models. A guideline from established conferences is that there should be between 6 and 12 volunteer engineers per 100 students to conduct the hands-on activities portion of the conference.

Implementation:

Follow the set of steps below for developing mathematics and science conferences. The *Directory of Programs and Services* contains a list of conference programs to contact for more information to help make your program a success!

Form a Committee

STEP 1

The first step to planning the conference will be to form a committee to develop and design the mathematics and science conference. However, this step is optional and depends on the size of the planned program and the agency implementing the program. For programs that are smaller in scope, forming a "full" committee is not necessary when two or three people can implement a particular program.

Even though only three to five people are necessary to organize a larger size conference, established programs suggest including at least 10 to 12 people on the committee. The committee should be large enough to facilitate fund raising and locating conference speakers. Remember to include teachers, school administrators, parents, and professionals from industry on the panel. Teachers and school administrators are especially important to include because they can offer valuable input about the mathematics and science content of the conference.

At this time, one person within the committee should be appointed to serve as program director. The director not only coordinates the program but also serves as the point of contact for questions and information about the program.

AWARDNESS

RETENTION

Curriculum

Committee responsibilities will include

- Establishing goals of the conference;
- Determining the target audience of the conference;
- Raising funds for the conference;
- · Offering suggestions and comments about program content; and

• Deciding on the method that will be used to evaluate the conference.

Set Goals and Determine a Target Audience

Before the content of the conference can be developed, it is important for the committee to define the goals of the conference. All of the activities included in the program will be chosen to meet the goals selected in this step. There are two types of goals that can be defined: behavioral goals and attitudinal goals. The effect of a behavioral goal is a change in behavior and the effect of an attitudinal goal is a change in attitude. Your committee can define one goal or several goals depending on the size and scope of the conference.

Following are several example goals from established conferences (7):

- · Portray mathematics and science activities as exciting.
- Provide conference participants with role models who are women working in fields that rely on mathematics and science.
- Encourage students to continue to enroll in mathematics and science classes.

STEP 1 (Cont.)

AWARDNESS

RETENTION

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A target audience for the conference program should be selected in conjunction with the goals of the conference. The target audience should be as specific as possible since the audience will influence the activities and academic content of the program. Conferences geared toward an elementary audience should primarily consist of short, hands-on activities that emphasize simple mathematics and science concepts as exciting. In contrast, conferences for a high school audience may include a career panel discussion with engineers or a college planning workshop.

STEP 2 (Cont.)

Review existing conference models with the committee. Generally, the best approach to plan the conference is to adopt an existing conference model for the specific site. Next, alter and adapt this model to fit the conference goals.

STEP

Develop the Conference Schedule

Established programs have found that the most effective element in their conference is hands-on activities. Hands-on workshops are designed to stimulate the students' interest in scientific or technical areas or to help them broaden their image of mathematics. These activities provide students with an experience as well as an awareness of how these fields of study relate to the outside world. There is no need to create your own hands-on activities, since established programs have numerous ideas and suggestions of hands-on activities.

Established programs suggest giving the primary responsibility for developing the hands-on workshops to the volunteers recruited (7). Each committee member should be paired with one volunteer to help them develop a hands-on activity. The topic of the activity should relate to the volunteer's field and not be too advanced for the target audience. The only other activity constraints are that the activity needs to be short enough to finish during one session and cannot require expensive or unattainable equipment. The volunteer speaker will need to thoroughly explain the activity and how it relates to the outside world.

It may also be useful to include career discussion panels in the conference. However, remember the target audience before adding this activity. Career panels are most effective for older audiences (e.g., high school audiences). To begin the discussion, speakers on the panel should discuss their education, career challenges, and what made them choose their profession. Next, the audience can be either broken into small groups or remain in one large group for the panel question-and-answer session (7).

RETENTION

CURRICULUM

Develop a Budget and Recruit Outside Sponsors

STEP

As stated previously, the budget required for one's conference will depend on the size and scope of the conference and the resources available. There are several different approaches to budgeting, budgetary cycles, and preparing the actual budget (8). Established programs suggest having the committee construct a list of the materials (i.e., brochures, food, activity materials) necessary for the conference and their cost. Next, the resources available to the committee can be used to acquire many items through donations. Consider the number of rooms needed for the workshops and special equipment that the facility will have to provide. For example, a high school administrator could donate the school's facilities for a Saturday afternoon.

The committee should also decide during this step whether a registration fee from conference participants will be necessary. If collecting a fee is necessary, remember to keep it very small. Established programs have commented that charging a registration fee is a good idea, since it forces students to make a commitment to attend the conference (7).

The final decision that the committee will need to make during this step is whether or not outside sponsors will need to be recruited. Soliciting corporate sponsors is a very time-consuming task and the benefits should be weighed carefully against the time expended.

Here are some tips on recruiting outside sponsors (7):

- 1. Select possible sponsors of the conference from state or local boards of education, colleges, teachers' organizations, PTA's, professional and social organizations, and businesses (those with stated affirmative action goals).
- 2. Don't waste time randomly contacting business agencies unless someone on the committee has a business contact.
- 3. Gauge what sponsors are likely to give *before* asking for money. Past contributions to other organizations will provide an indication of the relative amount of money to expect from an agency.

RETENTION

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- 4. Remember that sometimes "in-kind" contributions are just as valuable as monetary contributions. "In-kind" donations do not involve cash exchanges but involve donations of services (for example, secretarial help or printing and mailing services).
- 5. When contacting potential sponsors, explain the focus of the conference and the budget situation; then ask for a donation.

STEP 4 (Cont.)

Recruit Volunteers

The number of volunteer conference speakers needed depends on the size of one's program and the goals set by the committee set in Step 2. Generally, established programs suggest recruiting 6 to 12 volunteer speakers for every 100 students.

It is important that speakers be chosen carefully! If one's program is especially targeting women and minority students, it will be important to have women and minority engineer role models as conference speakers. One's volunteer presenters should be professional, friendly people who are enthusiastic about engineering. It is also helpful to enlist younger volunteers (e.g., college graduate students) so that students can identify with them.

Ask for suggestions from the committee about possible conference speakers. (It should already be known what fields the speakers will represent at the conference based on the goals that have been developed.) Use committee members' contacts to recruit speakers. Established conferences also suggest contacting colleges and professional societies for names and recommendations of possible speakers.

STEP 5

Here are some tips on recruiting volunteer conference speakers (7):

1. When initially calling potential speakers, remember to mention the name of the person who recommended them. Clearly state the purpose of the conference and the topic the volunteer is being invited to address.

RETENTION

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2. Ask potential volunteers if they would be interested in leading a handson workshop relating to their field. Also ask them if they would be willing to do the workshop more than once.

- 3. Several days after the initial call, confirm the time and date of the conference in writing. It is also recommended that the volunteer be provided with more information about the conference (i.e., conference brochure, tentative activities schedule, etc.).
- 4. Finally, if volunteer speakers are unavailable to participate in this conference, ask them if they would be willing to participate in a future conference. They could also be asked to recommend someone as a potential conference speaker in their field.

Publicity for the Conference

There are two different ways to publicize the conference: by personal contact and through the media. Personal contact is accomplished by having committee members spread the word about the conference to their friends and school contacts. Several members of the committee should also be appointed to contact mathematics and science teachers of the targeted grade level at local schools and provide them with information about the conference. Remember to include specific information about how students can register for the conference.

The media, specifically radio and newspapers, can also be used to provide information about the conference to the local community. Radio stations will usually do free community service announcements. Likewise, newspapers will usually print press releases. This can be accomplished by contacting the stations and newspapers to provide them with the conference information.

If it is decided to keep the size of the conference small, use only personal contact to recruit conference participants. After two or three schools have been contacted, the conference will probably be full. Using the media to publicize a small conference will result in having to turn away a large number of students.

STEP 5 (Cont.)

RETENTION

CURRICULUM

Implement, Then Evaluate the Program

STEP 7

It is extremely important to perform a pre-conference evaluation and a post-conference evaluation.

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success:

- Problems in the conference can be detected and corrected as soon as they
 occur.
- The effectiveness of the hands-on workshops can be evaluated so that improvements can be made next time.
- The overall impact of the conference can be assessed.

The easiest and most efficient way to evaluate a conference is through a questionnaire. Students should be asked to fill out the pre-conference questionnaire when they register, before any part of the conference begins. The post-questionnaire can be filled out at the end of the conference. Collect the questionnaires *immediately* after students are finished.

Keep the questionnaires brief and anonymous.

Here are some sample questions from established conference post-questionnaires (7):

- 1. To what extent did the conference increase participants' exposure to individuals who work in the engineering field?
- 2. To what extent did the conference increase the participants' awareness of mathematics and science courses?
- 3. To what extent did the conference increase the participants' interest in taking mathematics and science courses?
- 4. Which aspects of the conference were most successful?

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At the conclusion of the conference, questionnaires can also be distributed to conference speakers and committee members to gain their opinions about the conference.

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Conferences," have successful conference programs. They can be contacted for more information, help, or ideas.

AWARDNIDSS

RETENTION

CURRICULUM

ACTION PLAN: FIELD TRIPS/OPEN HOUSES

ARC Target Audiences:

- Elementary (K-6)
- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)

What are Field Trips/Open Houses?

Field trips/open houses provide an opportunity for secondary school and college students to visit the offices of civil engineering firms, state and local departments of transportation, and the facilities of engineering colleges. These tours give students a chance to interact with professional civil engineers and engineering professors and obtain information regarding careers in civil engineering. More importantly, students get a chance to see firsthand the jobs civil engineers perform.

What are the resources necessary to begin?

Time:

In general, it should take approximately 1 month to become involved in a field trip/open house.

Money:

Because the program provides that the students will visit the agency's office or facility and the agency will recruit volunteers from its staff to participate, expenditures for field trips/open houses will be minimal. If necessary, the updating and printing of the agency's recruiting materials (brochures, posters, etc.) will be the agency's primary expense. An additional optional expense is buying lunch for the students or handing out pencils, rulers, etc., with the agency's logo.

Related Resources:

- 1. There will need to be one person from the agency appointed to coordinate the field trip/open house. In addition to serving as a tour guide, this person will need to contact local schools, recruit volunteers in the agency, and put a presentation together.
- 2. Several volunteers will also be needed to give brief presentations about the types of jobs they perform, equipment they use, job responsibilities, and so on. If the program is especially targeting women and minority students, it will be important to have women and minority role models.

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Implementation:

Follow the set of steps below for developing field trips/open houses. The *Directory of Programs* and *Services* contains a list of field trip/open house programs to contact for more information to help make your program a success!

Contact Schools

1

STEP

Before picking up the telephone to contact schools to let them know of the program's availability, take time to decide on the type of student to be targeted. The target audience of the program will influence the activities and academic content of the field trip or open house.

Some issues to consider when choosing a target audience include

- Student grade level,
- Student interest in mathematics and science,
- Student grade-point average, and
- Student ethnicity and gender.

During Step 1, contact local schools or universities and let them know the agency is interested in holding an open house for their students. Specifically, try to contact a mathematics or science teacher in the school. Explain to the teacher that the purpose for the visit to the agency is so that students can explore career opportunities in civil engineering and gain an appreciation for the importance of mathematics and science. Offer to work with the teacher in developing the presentation and scheduling the open house.

It may also be worthwhile to consider contacting mathematics and science clubs in local schools, Girl and Boy Scout troops, Explorer Posts, and special programs (e.g., PRIME, PREP) in the area. These groups will generally be very interested in attending an open house at the agency.

Develop a Presentation

The type of presentation and tour to be designed will be governed by the type of student targeted in Step 1.

RETENTION

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Remember the target audience when designing the tour!

STEP 2 (Cont.)

For example, elementary students have a short attention span, so keep the tour brief. Also, any engineering concepts presented will need to be explained in simplified terms. Finally, include hands-on activities in your tour (i.e., show students surveying equipment or give a CAD system demonstration on a computer). These activities will help to maintain the interest of elementary school students throughout the tour.

In contrast, for a high school audience, the tour can be more technical. Depending on the interest level of the students in mathematics and science, engineering concepts can be presented in detail. For example, instead of just showing students surveying equipment, one can explain some of the theory and math concepts used in surveying. The length of the tour can also be extended for an older audience.

Now that it is clear the type of tour and presentation to be designed, a very important question must be addressed:

What aspects of the agency should be emphasized?

The answer to this question will help to decide what to include and not to include in the presentation.

Established programs offered the following ideas to include in the tour:

- Start the tour by showing the agency's recruiting video.
- Emphasize the computers and software the agency uses (e.g., CAD) with demonstrations.
- Include a tour of the environmental lab.

RETENTION

CURRICULUM

Recruit Volunteers to Give Presentations

The number of volunteers needed to make presentations will depend on the planned length of the tour established in Step 2.

Ideally, the volunteers should be professional, friendly people who have worked for the agency for several years. They should possess good communication skills and be enthusiastic about engineering. Remember to include women and ethnic minorities in the group of volunteers.

Personal contact is the key to getting people to volunteer to make presentations for the tour. Let each person approached know how long their presentation should be and if it is desired that they include a demonstration (e.g., computer software, etc.). Emphasize that the presentation is informal and that they should anticipate several questions from students.

Implement, Then Evaluate the Program

Evaluating the program will help make the next field trip or open house even more successful. Evaluation will indicate exactly what students found interesting in the tour and which demonstrations were the most successful. It can also show if a presentation was confusing or if a demonstration needs to be simplified. All of this information will help to revise and improve the tour and presentations.

The evaluation method used for this type of program should be kept simple and to the point. Two suggested methods are

- 1. At the end of the tour, ask students informally what they liked most and liked least in the presentations.
- 2. Give a questionnaire to the teacher to distribute to students back at school. Include several questions (no more than four or five) asking students about the tour.

Also remember to ask volunteers for feedback about the program.

STEP 3

AWARDNIBSS

RETENTION

CURRICULUM

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Field Trips/Open Houses," have successful programs. They can be contacted for more information, help, or ideas.

<u>Awareness</u>

RETENTION

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ACTION PLAN: PRINTED GUIDANCE MATERIAL

ARC Target Audiences:

- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)
- College (Junior-Senior)

What is Printed Guidance Material?

Printed guidance material includes posters, brochures, handouts, etc., that an organization can use to heighten awareness about the engineering profession. Most agencies/organizations use printed guidance material as a recruiting tool to highlight engineering job opportunities with their company. Printed guidance material can also be distributed as career information to junior and senior high school students.

What are the resources necessary to begin?

Time:

In general, approximately 2 or 3 months are required to develop new printed guidance material or revise existing guidance material.

Money:

The size of the budget depends on the quality of the materials one's agency desires. Depending on one's in-house capabilities, quality materials can be produced by the organization itself or with the help of a professional advertising agency. The type of materials developed will also affect the budget. For example, producing a video is more expensive than producing a brochure.

Related Resources:

- 1. One person from the agency should be appointed to coordinate the development of the printed guidance material.
- 2. Three or four engineers from the agency will also be necessary to form a committee to evaluate old and new printed materials.

<u>AWARIENIESS</u>

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Implementation:

Follow the set of steps below for developing printed guidance material. The *Directory of Programs and Services* contains a list of printed guidance material programs to contact for more information to help make your program a success!

Form a Committee

Before attempting to create or update printed guidance material, review existing printed material carefully. The most effective and efficient way to perform this evaluation is to form a committee of three or four individuals who work for the agency (4). Consider young engineers who have recently graduated from college to help on the committee. Remember to include women and ethnic minorities on the committee to reflect different opinions and impressions about the printed material.

Review and Evaluate Existing Guidance Material

Gather all of the brochures, posters, and displays that the agency is currently distributing. With the help of the committee, perform a thorough evaluation of the printed material.

As stated in NCHRP Report 347, check the following list of "essential elements" to be included in all printed guidance material (3). Try to identify which elements are lacking and those that must be added or updated.

Career information must be accurate (current) and provide the following:

⇒ Definition of civil engineering and its subdiscipline areas;

- ⇒ Salary structure (short-term and long-term ranges);
- ⇒ Working environment (office and field);
- ⇒ Advancement potential (managerial, technical, and entrepreneurial opportunities); and
- ⇒ Education requirements.

STEP 1

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- Information must avoid perception of "selling" the profession.
- Information should link the civil engineer with projects addressing socio-technical problems.
- Information should stress the *diversity* of the civil engineering profession. Materials should be developed to specifically target underrepresented groups (ethnic minorities and women).
- Materials developed should target the pipeline (e.g., high school students) and/or influencer groups (e.g., parents, teachers).

• Information should provide guidance on sources of financial support, describe intervention (retention) efforts, and offer sample descriptions of engineering enrichment programs.

The AASHTO Recruitment and Retention Guide provides additional information for evaluating one's printed material. The Guide states that the most effective printed guidance materials have four central elements (4):

- Positive Image Overcomes negative images of the engineering profession.
- Clear Mission Reflects a clear and dynamic sense of mission.
- Sense of History Addresses the history and evolution of engineering in your agency.
- Effective Sell Portrays one's agency as active, engaged, involved, and up-to-date.

STEP 2 (Cont.) AWARDNESS

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The Guide suggests evaluating one's printed guidance material against these four criteria.

STEP 2 (Cont.)

A checklist is provided in Chapter 2, p. 13, of the AASHTO Recruitment and Retention Guide to aid in the evaluation.

Another aspect of one's evaluation should be to determine the *target audience* of the materials. Do the current printed materials succeed in reaching its target audience? For example, materials targeting high school students should include information about the educational requirements necessary to become an engineer. Likewise, information in materials targeting recently graduated college students should emphasize professional opportunities and career growth.

During this step, take time for the committee to discuss how the final printed guidance material is going to be distributed and used. Also consider how many copies are needed.

The last portion of the evaluation should consist of comparing the agency's printed materials with the printed materials of other related agencies and transportation programs in the State (4). It should be easy to tell very quickly how one's guidance material compares with the other materials. Reviewing different materials can also help provide ideas when beginning to develop new posters, brochures, and so on.

Identify an Available/Desirable Budget

When the evaluation of the agency's printed materials is completed, the results should provide a clear sense of which materials need to be revised or completely redone. Now is the time to begin planning a budget.

The first step in this process is to identify the amount of money one's agency has available to spend. Depending on the size of one's budget, it may be necessary to prioritize by order of importance which printed materials to improve or develop. In general, choose the materials that will target the greatest audience and will be used most frequently (e.g., brochures).

The next issue to be addressed is determining who will produce the new materials. The AASHTO Recruitment and Retention Guide suggests looking first to one's inhouse audio-visual and print specialists to create and produce the materials (4).

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The finished guidance material must look professional!

STEP 3 (Cont.)

Depending on one's in-house capabilities, quality materials can be produced by the agency or with the help of a professional advertising agency. Send out a Request for Proposals to obtain competitive bids for the work. However, before making a final decision, talk to previous clients of the ad agencies to make sure they were satisfied with their finished product.

Review and Evaluate a Draft of the New Materials

As soon as the new printed guidance material is received from the in-house audiovisual staff or a professional ad agency, it will need to be evaluated. Assemble, at a minimum, the members of the committee formed in Step 1 for this purpose. Focus groups composed of students, parents, and educators can also be used to preview drafts of the materials.

Judge the new guidance material against the same criteria used to evaluate the old material. Use the checklist of essential elements in Step 2, p. 33, or the checklist in Chapter 2, p. 13, of the AASHTO Recruitment and Retention Guide.

Here are some other tips for evaluating the finished guidance material:

- Do the final printed materials look professional?
- Do the new materials accurately convey the desired message about one's agency?
- Do the new materials include all of the elements that were found lacking in the old materials?

STEP

4

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RETENTION

Curriculum

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Printed Guidance Material," have developed printed guidance material. They can be contacted for more information, help, or ideas.

RETENTION

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ACTION PLAN: SCHOOL PRESENTATIONS

ARC Target Audiences:

• Elementary (K-6)

• Junior High (7-8-9)

• Senior High (10-11-12)

What are School Presentations?

School presentations provide an opportunity for practicing engineers to visit schools and increase the awareness of students, teachers, and counselors about the profession of engineering.

What are the resources necessary to begin?

Time:

Approximately 2 to 3 months are necessary to begin and develop a school presentation program.

Money:

Since volunteers will be recruited from one's agency to give presentations in schools, expenditures for school presentation programs will be minimal. If necessary, the updating and printing of the agency's recruiting materials (brochures, posters, displays, etc.) will be the primary expense.

Related Resources:

- 1. One person from the agency should be appointed as program director to coordinate the school presentation program.
- 2. A minimum of two engineers will need to be recruited as volunteers. Most established programs suggest sending pairs of engineers into schools to make presentations. If the program is especially targeting women and minority students, it will be important to have women and minority engineer role models.
- 3. A commitment to participate in the program should be obtained from at least one local school in the area.

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4. A commitment to participate in the program should also be obtained from at least two teachers in the targeted school. Gaining the support of teachers is important to the success of the program!

Implementation:

Follow the set of steps below for developing school presentations. The *Directory of Programs* and *Services* contains a list of school presentation programs to contact for more information to help make your program a success!

Set Goals and Establish a Target Audience

A school presentation program begins by deciding what one's program is to accomplish. There are two different types of goals that can be defined: behavioral goals and attitudinal goals. The effect of a behavioral goal is a change in behavior and the effect of an attitudinal goal is a change in attitude. The goals that are set will need to be specific so that they can be accomplished successfully.

STEP 1

Following are Example Goals:

- To provide students with an incentive to enroll in more mathematics and science classes and
- To generate interest in the field of engineering.

Determine a target audience for the school presentation program at the same time the goals are set. The target audience should be as specific as possible, because the audience will influence the activities and academic content of the program. For example, every age group has different needs. An advanced placement high school audience will understand advanced mathematics and science concepts that an elementary school audience would not understand. Also, an elementary school class has a shorter attention span then a high school class. Each school presentation will have to be tailored to the target audience.

School presentation programs can target any student group from K-12. In determining the target audience, consideration should be given to the following points:

- Student grade level,
- Student grade-point average, and
- Student ethnicity and gender.

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Form a Committee

This step is optional depending on the size of one's program. If one plans to target a large number of schools, forming a committee is an effective way to make decisions about how to design the program. A committee can also divide program responsibilities among members (e.g., contacting schools and recruiting volunteers). Remember to include teachers, school administrators, parents, and professionals from industry on the committee. It is important to include teachers on the committee for two reasons. The first is that gaining teacher support will be crucial to the success of one's program. The second reason to include teachers on the committee is to gain their input about the content of the school presentation.

During this step, one person within the committee should be appointed to serve as program director. The director not only coordinates the program but also serves as the point of contact for questions and information about the program. It may be beneficial to form several subcommittees to divide the program responsibilities (i.e., volunteer committee, school relations committee, etc.). The size of one's program should dictate whether or not subcommittees need to be formed.

It is important for the committee to address the following issues:

- Will we need to use incentives to encourage people to volunteer?
- What schools will we target with our resources?
- Will we offer an orientation session for volunteers before they go into the classroom?
- Will each volunteer develop their own classroom presentation or will the committee develop the presentation they will present?
- How will the program be evaluated?



Evaluating one's program is very important! It is important to plan how to evaluate the program before the program is under way.

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Contact Schools

STEP 3

Once the committee is formed and a director has been appointed, it is time to begin contacting schools and universities to participate in one's program. The number of institutions and the type of students to be targeted depend on the goals and target audience of the program.

Some things to consider when contacting schools include the following:

- Student grade level,
- Student interest in mathematics and science,
- Student grade-point average, and
- Student ethnicity and gender.

Most successful established programs suggest targeting one or two schools during the first year. This will keep the program small and manageable and give the committee a chance to test and refine the program presentations. It will be fairly easy to determine within the first few school presentations the parts of the program that are working and the parts that need revising.

Here are some ideas from the program Discover "E" on how to begin one's partnership with students and teachers (6):

- 1. Find out something about the school that has been targeted (e.g., average student GPA, interest level of students in mathematics and science).
- 2. Have specific ideas about what a classroom presentation is to accomplish (e.g., is the intent to introduce students to engineering in general or to a specific field of engineering?).
- 3. Determine how much time the agency will spend in the classroom (e.g., one period or all day).

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4. Contact local mathematics and science supervisors, principals, and teachers to tell them about one's presentation program. If the names of mathematics or science teachers are known, contact them personally. Also, Discover "E" suggests: "Stress the importance of your visit to help stimulate mathematics and science motivation."

STEP 3 (Cont.)

5. Once the teacher has agreed to participate, plan a meeting with the teacher to review the material to be covered in the presentation.

Recruit Volunteers to Make Presentations

The number of volunteers that will need to be recruited depends on the goals of one's program (Step 1) and the number of contacted schools interested in the program (Step 3). However, most established programs recommend sending pairs of volunteer engineers into schools to make presentations. Engineers feel more comfortable and the presentations are more interesting with two engineers present.

Ideally, the engineers chosen from one's agency as volunteers should be professional, friendly people who are enthusiastic about the field of engineering. They should also possess good communication skills.

Some established programs have had problems recruiting volunteers during initial program development without offering incentives. This problem is usually only temporary. Once knowledge of the successful program spreads, it should become easier to recruit volunteers. Until then, most program directors stress that personal contact is the key to getting people to volunteer for one's program without specific incentives.

Following are additional ideas to encourage volunteers:

- Time off during normal work hours to attend an orientation session
- Time off during normal work hours to make school presentations

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Train Volunteers

STEP 5

Before one's volunteers make classroom presentations, they should attend an orientation session. If the program is small and only involves a few volunteers, the orientation session can be a short, informal meeting.

The purpose of this session is to give volunteers

- Background information on the purpose of the school presentation program (i.e., the goals of the program) and
- Information about the schools and students to be visited.

Prepare a packet of materials to hand out to each volunteer during this session. This packet should be compiled even if each volunteer is responsible for developing their own presentation. By including tips about how to prepare a successful classroom presentation, this packet of information will help to ensure a measure of uniformity between the volunteers' classroom presentations. Also, include sample evaluation questionnaire sheets for engineers to distribute to teachers and students at the conclusion of the presentation.

If possible, it is a good idea to invite one or two teachers from the targeted schools to attend the orientation session. These teachers can give the volunteers helpful input about preparing their classroom presentations and an idea about what to expect when they enter the classroom (i.e., types of questions students typically ask). Some established programs have developed videos and written material to help engineers and scientists to visit and interact with K-12 students. For more information contact:

Chemists in the Classroom

American Chemical Society Pre-High School Division 1155 16th Street, NW Washington, DC 20036

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Sharing Science with Children:
A Survival Guide for Scientists
and Engineers

American Association for the Advancement of Science (AAAS) Department SEN 1333 H Street, NW Washington, DC 20005-4792

STEP 5 (Cont.)



Keep the orientation session brief! People will not volunteer for a program if the training is too time-consuming or demanding.

Implement, Then Evaluate the Program

Once the volunteers have started making classroom presentations, it is time to begin evaluating the program.

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success:

- Problems in one's program can be detected and corrected as soon as they occur.
- The effectiveness of one's orientation session can be evaluated so that improvements can be made.
- The overall impact of the presentations can be assessed.

There are two fairly simple methods to evaluate student reactions to school presentations. The first method is to verbally ask students informally at the end of the presentation what they liked about the presentation, what they didn't like, and so on. Keep this session brief by asking no more than three or four questions. Also remember the age of the audience when phrasing the questions.

The second evaluation method is to pass out questionnaires to students at the conclusion of the presentation. Keep the questionnaire brief (four or five questions maximum) and easy to understand. Collect the questionnaires *immediately* after the students finish them.

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The committee should also formulate and distribute questionnaires to teachers and volunteer presenters regarding their opinions about the presentation.

STEP 6 (Cont.)

Need more information?

The agencies listed within the *Directory of Programs and Services*, "School Presentations," have successful school presentation programs. They can be contacted for more information, help, or ideas.

RETENTION

CURRICULUM

ACTION PLAN: VIDEO AND ADVERTISING

ARC Target Audiences:

• Elementary (K-6)
• Junior High (7-8-9)
• Senior High (10-11-12)
• College (Freshman-Sophomore)
• College (Junior-Senior)

What is Video and Advertising?

Both video and advertising are used by organizations to sell their services. However, they can also enhance the image and promote an in-depth awareness of the engineering profession and career opportunities. Advertising can be printed material (magazine ads, newspaper ads, etc.) or radio and television advertisements. The materials, particularly television ads and promotional videos, also have use as recruiting tools and can convey career information to junior and senior high school students. These materials can also be used by individuals or groups to supplement retention and curriculum strategies.

What are the resources necessary to begin?

Time:

In general, it should take approximately 2 months to develop advertising materials. Depending on the length and content of one's video, the video may take longer to produce.

Money:

The size of the budget depends on the quality of the materials one's agency desires. Depending on the agency's in-house capabilities, quality materials can be produced by one's organization or with the help of a professional advertising agency. Producing a video is very expensive and companies have spent as much as \$10,000 to \$20,000 to create videos.

Related Resources:

1. One person from the agency must be appointed to coordinate the development of the video and advertising materials. The agency should consider hiring a full-time person with a marketing background for this job if the agency plans to advertise frequently on TV, in magazines, and so on.

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2. Three or four engineers from the agency will also be needed to form a committee to evaluate old and new videos and advertising materials.

Implementation:

Follow the set of steps below for developing video and advertising materials. The *Directory of Programs and Services* contains a list of video and advertising programs to contact for more information to help make your program a success!

Form a Committee

Before attempting to create or update videotapes or advertising material, review existing videos or advertising materials carefully. The most effective and efficient way to perform this evaluation is to form a committee with three or four individuals who work for the agency. Consider young engineers who have recently graduated from college to help on the committee. Remember to include women and ethnic minorities on the committee to reflect different opinions and impressions about the videotape and advertising materials.

Review and Evaluate Existing Video and Advertising Material

Gather all of the videos and advertising material the agency is currently using. Also gather videos and advertising material from other engineering agencies and even agencies in other fields (finance, banking, etc.). This additional material will help the committee evaluate the agency's video and advertising materials more thoroughly and more critically. Viewing materials from other agencies will also give the committee ideas for developing or refining new or existing videos and ad material.

Following are some of the major questions the evaluation should address:

What elements are lacking in the current video and advertising material?

STEP 1

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• Is the current video outdated? Does it show women and ethnic minorities as part of the engineering team?

• How will the material be used and distributed?

Begin the evaluation by checking the list of "essential elements" to be included in all video and advertising material (3). This list is located on p. 33 of "Printed Guidance Material" in this manual. Try to identify which elements are currently lacking and those that must be added or updated.

The AASHTO Recruitment and Retention Guide provides additional information for evaluating video and advertising material (4). The Guide states that the most effective materials have four central elements:

- Positive Image Overcomes negative images of the engineering profession.
- Clear Mission Reflects a clear and dynamic sense of mission.
- Sense of History Addresses the history and evolution of engineering in one's agency
- Effective Sell Portrays one's agency as active, engaged, involved, and up-to-date.

The Guide suggests evaluating the video and advertising materials against these four criteria.

A checklist is provided on Chapter 2, p. 13, of the AASHTO Recruitment and Retention Guide to aid in one's evaluation.

STEP 2 (Cont.)

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Another aspect of the evaluation should be to determine the *target audience* of the materials. Do the agency's current video and ad materials succeed in reaching their target audience? For example, if a video is targeting newly graduated engineers, it should focus on the agency's new engineers doing real tasks in the real world and making a difference right out of school.

STEP
2
(Cont.)

STEP

Identify an Available/Desirable Budget

When evaluation of the agency's video and ad materials is complete, the evaluation should provide a clear sense of which materials need to be revised or completely redone. Now is the time to begin planning a budget.

The first step in this process is to identify the amount of money that is available and desirable for the agency to spend. Depending on the size of the budget, it may be necessary to prioritize by order of importance which materials to improve or develop. If one's agency does not have a large enough budget to cover the expense of a video, one may elect to either recruit an outside sponsor to help cover the cost or hold off on developing a video until more funds are available. Remember, the finished product needs to look professional! For example, the video must be filmed in color with a professionally recorded music track (4).

STEP

Contract an Ad Agency to Produce the Video and Ad Material

The next issue to be addressed is who will produce the new materials.



The finished materials must look professional!

Depending on one's in-house capabilities, quality materials can be produced by one's own agency or with the help of a professional advertising agency. Send out Requests for Proposals to obtain competitive bids for the work. However, before making a final decision, talk to previous clients of the ad agencies to make sure they were satisfied with their finished product (4).

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Evaluate a Draft of the New Material

STEP 5

As soon as the new video or advertising material is received from your in-house audiovisual staff or a professional ad agency, it will need to be evaluated. Assemble, at a minimum, the members of the committee formed in Step 1 for this purpose. Focus groups involving students, parents, and educators can be used to preview drafts of the materials. Judge the new material against the same criteria used to judge the old material. Use the checklist of essential elements in Step 2, p. 33, or the checklist in Chapter 2, p. 13, of the AASHTO Recruitment and Retention Guide.

Here are some other tips from the AASHTO Recruitment and Retention Guide for evaluating the new video (4):

• Does the video portray an accurate picture of the agency?

- Does the video look professional?
- Has one avoided adding things into the video that will shorten its useful life and make it outdated quickly (e.g., trendy music)?

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Video," have developed videos and advertising materials. They can be contacted for more information, help, or ideas.

CHAPTER 4

RETENTION PROGRAMS

Every student entering kindergarten is already a member of the civil engineering pool; each is also a member of every other potential career pool. The trend has been such that progressively fewer students choose and retain civil engineering as a profession. Specifically, women and ethnic minorities remain greatly underrepresented in selecting engineering and civil engineering for study. When compared to the retention rates for the traditional pipeline member (the white male), the retention of ethnic minorities and women in civil engineering programs is low (3).

Retention efforts are necessary at both the pre-college and undergraduate levels. Additionally, these retention efforts must also be of a more personal nature (i.e., intervention) as compared to the awareness strategy. To retain pre-college students in the civil engineering pipeline, emphasis must be directed toward several areas, including (3)

- 1. Building positive attitudes and self-confidence in mathematics and science;
- 2. Helping students understand the consequences of curriculum and course choices, so that later options will not be prematurely closed; and
 - 3. Providing appropriate role model and mentor opportunities.

Retention of undergraduate students in civil engineering requires efforts in several areas, including (3)

- 1. Delivering appropriate academic support;
- 2. Developing student peer-network relationships and making use of faculty mentoring; and
- 3. Explaining the relationship between academic preparation and chosen career.

The Retention Programs in this guide are primarily designed for audiences of students in grades 7–12 and college. Some strategies for engineer and transportation professional involvement with Retention Programs include the following: judging science fairs or coaching teams of students for competitions, acting as a mentor (role model) to a student or group of students, beginning a scholarship or fellowship program, and hiring students as summer engineering interns. The purpose of these programs is to get engineers and transportation professionals involved with students to increase the retention rate of students interested in engineering. Competitions, science fairs, and summer intern programs also provide engineers and transportation professionals with an opportunity to illustrate the relevancy of mathematics and science for solving real-world engineering problems.

RETURTION

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ACTION PLAN: COMPETITIONS AND SCIENCE FAIRS

ARC Target Audiences

- Elementary (K-6)
- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)

What are Competitions and Science Fairs?

Competitions and science fairs introduce students to engineering problems and how mathematics and science can be applied to solve these problems in the real world.

What are the resources necessary to begin?

Time:

Depending on the size of the competition or science fair, a minimum of 6 months will be needed to organize and develop one's program. Most established programs have commented that it generally takes two competition cycles (2 years) before a program is firmly established.

Money:

The budget needed for one's program will depend on the size and scope of the competition or science fair as well as the resources available. An expenditure of approximately several hundred dollars will be necessary if one's agency joins an established competition. Beginning a new competition will cost more than joining an established competition.

Related Resources:

- 1. A committee of at least 10 people will be needed to design the competition or science fair.
- 2. One person from the committee should be appointed to serve as program director.

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Implementation:

Follow the set of steps below for developing competitions and science fairs. The *Directory of Programs and Services* contains a list of competition and science fair programs to contact for more information to help make your program a success!

Decide Whether to Start a New Competition or Join an Established Competition

STEP 1

There are several advantages to joining an established competition like MATHCOUNTS, Chemistry Olympiad, or TEAMS (Tests of Engineering Aptitude, Mathematics, and Science). First, participating in an established competition requires less money, time, and resources from one's agency than beginning a new competition. However, participating in an established competition will still require a significant expenditure. The reason is that most established national programs still require participating agencies to recruit volunteers and to obtain funding in their area.

Joining an established competition also provides ideas about how to design, organize, and implement a new competition. It may be useful to participate in established programs to gain experience and ideas about science fairs and competitions, including

- Ideas about how to set up a competition (rules, tests, grading, judging),
- Experience designing a realistic budget, and
- Experience recruiting sponsors.

Exposure to established competitions will help one's organization to avoid some of the initial problems faced by established programs.

Form a Committee

STEP 2

The first step in developing a new competition or science fair is to form a committee. (For programs that are smaller in scope, forming a "full" committee is not necessary when two or three people can implement the program.) Established programs suggest including at least 10 people on the committee. Invite teachers, school

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administrators, and professionals from industry to serve on the committee to provide input about the academic content of the competition or test. Also, include on the committee any teachers or professionals that have been involved with previous competitions or science fairs. The committee should also consider contacting established programs for help or ideas.

STEP 2 (Cont.)

At this time, one person within the committee should be appointed to serve as program director. The director not only coordinates the program but also serves as the point of contact for questions and information about the program.

Committee responsibilities will include the following:

- Choosing the target audience of the program.
- Deciding on the format of the competition (e.g., multiple choice test, science fair, design competition).
- Developing the competition rules.
- Deciding on judging criteria.
- Raising funds and recruiting sponsors.

Design the Competition and Rules

Before designing the program, select the target audience of the competition. The audience chosen will affect the goals and design of the entire program. For example, the judging criteria for an elementary science fair and a high school science fair will be different. Also, the academic content of a junior high school mathematics or science competition will need to be different from the academic content of a senior high school mathematics or science competition.

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In selecting the target audience, the committee needs to consider the following points:

- Student grade level,
- Student interest in mathematics and science,
- Student ethnicity and gender, and
- Student grade-point average.

Choose the format of the competition, once the target audience of the program has been selected. Established programs suggest first picking a competition format and then choosing an established competition model to adapt to one's competition site. Using an existing model will save time.

Sample competition formats and example programs include the following:

• Individual or team multiple-choice tests (TEAMS - Tests of Engineering Aptitude, Mathematics, and Science)

These tests work well with a large group of students because the tests can be scored by a computer and students can work individually or in teams. The tests are developed by the program committee and are administered by volunteers. After each round of tests, the top scoring students advance to the next round. Continue this process until the top 5 or 10 students are determined. Some established programs award prizes to all students who reach certain levels. For example, students who reach the third round of tests are all awarded certificates.

Individual or team partial-credit test (MATHCOUNTS, Chemistry Olympiad)

The main difference between multiple-choice tests and partial-credit tests is the method of scoring the tests. Partial credit exams must be scored individually by hand. Depending on the number of students participating in the competition, a large number of volunteers will be necessary to grade exams. Since the problems are partial credit, established programs have commented that the test questions can have a higher degree of difficulty than multiple-choice test questions.

STEP 3 (Cont.)

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• Science Fairs (Rockwell International)

Depending on the size of the competition, science fairs can last 2 or 3 days. The target audience of the science fair will determine the categories in which to classify students' projects for judging. For example, a grade school science fair may only have two divisions: physical science and natural science. A high school science fair may have specialized categories like chemistry, physics, or medicine. Volunteers will be necessary to register students as well as to judge the projects. Sponsors may need to be recruited to donate prizes for the winning projects. It will take approximately several months to plan and organize a science fair.

• Design Competitions (Vision 2000 Design Challenges)

Design competitions are very similar to science fairs, except that every design in the competition is built to solve a particular problem. For example, in egg drop competitions, each structure is designed to support an egg without cracking the egg when it is dropped from a specified height. A number of different competitions can be held, with the winners from each competition advancing to the next level. Generally, design competitions are smaller in scope than science fairs. Even though fewer volunteer judges are necessary, volunteer engineers may be needed to make classroom presentations to explain design concepts and methods to students.

For more information about school presentations:

See p. 38 of "School Presentations"

For the next step in designing a competition, break the committee up into groups and assign different tasks to each group. For example, subcommittees can develop competition rules, judging criteria, sample competition test questions, and so on. However, after each subcommittee completes its task, the entire committee should discuss and approve the competition.

STEP 3 (Cont.)

RETENTION

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Develop a Budget and Recruit Outside Sponsors

STEP 4

The budget required for the competition will depend on the size and scope of one's competition and the resources available. Probably the largest expenditures in one's budget will be renting a facility for a science fair or competition test and providing prizes for the winners.

The committee should also decide during this step whether a registration fee will be required of the competition participants or the participating schools. For example, MATHCOUNTS charges each school that participates in its program a \$30 fee. If collecting a fee is necessary, remember to keep it very small. Established programs have commented that charging a registration fee is a good idea, because it forces students and teachers to make a commitment to participate in the competition (7).

The final decision that one's committee will need to make during this step is whether or not outside sponsors will need to be recruited. Soliciting corporate sponsors is a very time-consuming task and the benefits should be weighed carefully against the anticipated time required.

Recruiting outside sponsors might be necessary if

- A large number of students are participating in the competition and rental of a large facility is needed,
- Outside help is necessary to develop or score competition exams, or
- College scholarships or large sums of money are to be offered as prizes.

Remember, sponsors can contribute more than just money to one's competition. For example, prizes can be donated, or secretarial and clerical help can be donated.

For more information on recruiting corporate sponsors:

See p. 22 of "Conferences

Recruit Volunteers

The number of volunteers necessary depends not only on the size of one's competition but also on the competition format selected in Step 3. For competitions using multiple-

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choice tests, several volunteers will be needed to proctor the exams. For competitions using partial-credit tests, volunteers will be needed to proctor as well as to grade the exams. For science fairs, volunteers will be needed to judge projects and register students. For design competitions, one or two volunteers will be needed to judge the competition and several volunteers will be needed to make classroom presentations to students participating in the competition.

STEP 5 (Cont.)

Some established programs have had problems recruiting volunteers during initial program development without offering incentives. Most program directors stress that personal contact is the key to getting people to volunteer for a program without specific incentives. Also, be sure to inform volunteers about the amount of time the competition will take and exactly what type of job they will be performing.

Following are additional ideas to encourage volunteers:

- Time off during normal work hours to judge projects in a science fair and
- Time off during normal work hours to make school presentations to students in a design competition.

Contact Schools to Participate

Once the process of designing the competition and recruiting volunteers has begun, contact schools and universities to participate in the competition. Keep in mind the target audience selected for the program when contacting schools. Send schools and teachers information about the competition including competition rules, judging criteria, student registration forms, and competition entrance fees.

Some things to consider when contacting schools include

- Student grade level,
- Student interest in mathematics and science,
- Student grade-point average, and
- Student ethnicity and gender.

Most successful established programs suggest targeting one or two schools during the first year of the program. This will keep the competition relatively small and manageable and give the committee a chance to deal with any problems that arise.

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Implement, Then Evaluate the Program

STEP 7

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success:

- Problems in one's competition can be detected and corrected as soon as they occur.
- The overall impact of the competition can be assessed.

The easiest and most efficient way to evaluate a competition is through a questionnaire. At the conclusion of each competition level, distribute questionnaires to competition participants, volunteers, judges, and members of one's committee.

Keep questionnaires brief and anonymous and collect the questionnaires immediately after students are finished with them. Possible questions include

- 1. What aspects of the competition did you enjoy most/least?
- 2. To what extent did the competition increase your interest in taking more mathematics and science classes?

Use the information obtained from the program evaluations immediately to begin refining the competition.

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Competitions and Science Fairs," have successful competition and science fair programs. They can be contacted for more information, help, or ideas.

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ACTION PLAN: MENTORING

ARC Target Audiences:

- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)

What is Mentoring?

Mentoring is a way for established professionals to reach out with advice and encouragement to students in their own field or students at critical decision-making points in their lives. Mentoring programs in this manual refer to partnership programs between schools and public transportation agencies, academic institutions, and private sector agencies. In these programs, engineers act as role models to offer guidance and support to students.

What are the resources necessary to begin?

Time:

Depending on the size of the program and the mentoring activities planned, it will take anywhere from 1 month to 1 year to get the program started.

Money:

Generally, state transportation agencies depend on money appropriated for a mentoring program in the state budget. This amount varies from state to state and from year to year. Private sector agencies should obtain commitments from at least three corporate sponsors to help support and begin a mentoring program.

Related Resources:

- 1. There needs to be one person appointed to serve as program director. Depending on the size of one's program, this may or may not be a full-time job.
- 2. A minimum of two engineers will need to be recruited as volunteers. Most established programs suggest sending engineers into schools to make presentations in pairs of two. If the program is especially targeting women and minority students, it will be important to have women and minority engineer role models.

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- 3. A commitment to participate in the program should also be obtained from at least two teachers in the targeted school. Gaining the support of teachers is important to the success of the program!
- 4. A commitment to participate in the program should be obtained from at least one local school in the area.

Implementation:

Follow the set of steps below for developing mentoring programs. The *Directory of Programs and Services* contains a list of mentoring programs to contact for more information to help make your program a success!

Set Goals

The first important step to beginning a mentoring program is deciding what the program is to accomplish. For example, one will need to target a specific grade level and then choose which schools in the area to contact.

Following are Example Goals:

- To generate interest in the field of engineering,
- To provide minority students with role models who are minority engineers, and
- To provide students with an incentive to stay in school.

Form a Committee

Forming a committee is a good way to make decisions about how to design and operate a mentoring program. Potential volunteer mentors, school administrators, and mathematics and science teachers should be included in the group. At this time, one person within the organization should be appointed to serve as program director. The director not only coordinates the program but also serves as the point of contact for questions and information about the program. One may also consider forming several subcommittees to divide the program responsibilities (i.e., fund raising committee, school relations committee, etc.). The size of the program should dictate whether or not subcommittees need to be formed.

STEP 1

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It is important for the committee to address the following issues.

- Will outside support (financial and personnel) be needed to sponsor the program, or can the agency, sponsor the program independently?
- How will people be encouraged to volunteer?
- What schools will be targeted with available resources?
- Will the mentors be formally trained by the agency, or will they be expected to develop their own program?
- What is the program structure?

Here are ideas from successful agency programs:

- Encourage interested students to visit the agency office(s) for a tour.
- Encourage mentors to meet informally with interested students.
- Encourage mentors to remain in contact with the classroom teacher even after he/she has made the classroom presentation.
 - How will the program's effectiveness be evaluated?



Evaluating the program is extremely important! The process for evaluating the program should be planned before the program is under way. Two of the most popular evaluation methods currently in use are student tracking and surveys (5).

STEP
2
(Cont.)

RETENTION

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Involve Outside Sponsors

STEP 3

If the agency mentoring committee has decided the agency lacks the funds or human resources to begin a successful program, outside sponsors will need to be recruited. Unfortunately, the level of funding often determines the success of a program. For this reason, it is important to spend time working on fund-raising strategies during the initial stages of program development. As stated in Step 2, depending on the size of the program, it may be necessary to set up a subcommittee to handle fund raising.

Appeal to the following:

- Private industry/companies and
- Government funding for special programs.

Here are some tips from established programs about how to recruit corporate sponsors:

- First and most important—Personal contact is the key to obtaining corporate funding. Networking at industry functions and talking to personal contacts in other companies are good ways to get a "foot in the door" of a company to ask for program funding.
- If possible, recruit the CEO of an industry-leading company in the area to serve on the program committee. Through a letter-writing or telephone campaign, one can use corporate contacts to obtain funding.
- The direct approach can also be very effective. Simply writing brief letters to target companies can help obtain necessary funding. However, remember to follow up the letters with personal telephone calls to each company.

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Recruit Volunteer Mentors

STEP 4

The number of mentors a program will need depends on the goals set by the committee in Step 1. However, most established programs recommend sending volunteer engineers into schools to make presentations in pairs of two. The engineers feel more comfortable and the presentations are more interesting with two engineers present.

If one's program is especially targeting women and minority high school students, it will be important to have women and minority engineer role models.

Ideally, one's volunteer mentors should be professional, friendly people who have worked for one's agency approximately 5 years. (The mentor must be very familiar with the agency's overall operations.)

Mentors should possess good communication skills and be enthusiastic about engineering.

See Chapter 4, p. 16, of the AASHTO Recruitment and Retention Guide.

Some established programs have had problems recruiting volunteers without offering some incentives. However, most program directors stress that personal contact is the key to getting people to volunteer for a program without specific incentives.

Additional ideas to encourage volunteers include

- Time off during normal work hours to make school presentations and
- Compensation time as appropriate.

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Target Schools

The number of schools and the type of students to be targeted depend on the goals of one's program.

Some things to consider include

- Student grade level,
- Student grade-point average,
- Student ethnicity and gender, and
- Student interest in mathematics and science.

Most successful established programs suggest starting out the first year by targeting only one or two schools. This approach will keep the program small and manageable and give the committee a chance to test and refine program activities. It will be fairly easy to determine within the first year the parts of the program that are working and the parts that need revising. During the second year if it is decided to expand the program to more schools, most of the bugs will be worked out of the activities and the program will run smoothly.

Here are some ideas from the program Discover "E" on how to begin one's partnership with students and teachers (6):

- Find out something about the school that has been targeted (e.g., find out if the school has any special math and science activities and clubs).
- Have specific ideas about what a classroom presentation is intended to accomplish (e.g., is the intent to introduce students to engineering in general or a specific field of engineering?).
- Determine how much time will be spent in the classroom (e.g., one period or all day).

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Train Mentors

Before any of the volunteer mentors begin to visit the target schools, they should attend a training session or information session for mentors (9).

The purpose of this session is to give mentors

- Background information on the purpose of the mentoring program,
- Information about the roles and responsibilities of a mentor, and
- Information about the schools and students to be visited.

It will be extremely helpful to prepare a packet of materials to hand out to the mentors during this session. This is especially true if there are a large number of mentors. The packet should contain information restating the goals of the program, the responsibilities of a mentor, and, most importantly, tips about how to prepare a successful classroom presentation. This packet of information will help to ensure a measure of uniformity among the volunteer mentors' classroom presentations.



Keep the mentor session brief! People will not volunteer for a program when the training is too time-consuming or demanding.

Implement, Then Evaluate the Program

Now that the mentors have started visiting schools and making presentations, it is time to begin evaluating the program.

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success:

- Problems in a program can be detected and corrected as soon as they occur.
- The effectiveness of the mentor training session can be evaluated so that improvements can be made.
- The overall impact of the program can be assessed.

STEP 6

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The following four-step guide for program evaluation was developed by the U.S. Department of Education (5).

- 1. Decide which *components* of the mentoring program need to be evaluated.
- 2. Formulate specific and clearly stated evaluation questions.

Examples:

Are the training sessions too long?

Do the training sessions meet mentor needs?

What topics were covered in classroom presentations?

Were they helpful to students?

- 3. Decide on data collection methods. Two of the most popular evaluation methods currently in use are student tracking and surveys. The first evaluation method tracks individual student progress upon entering the program throughout college. Surveys take the form of questionnaires distributed to people who are involved with the program (i.e., teachers, engineers, and students).
- 4. Plan how the evaluation data will be used.

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Mentoring Programs," have successful mentoring programs. They can be contacted for more information, help, or ideas.

See Chapter 7, p. 6, of the AASHTO Recruitment and Retention Guide.

STEP 7 (Cont.)

RETENTION

CURRICULUM

ACTION PLAN: SCHOLARSHIPS AND FELLOWSHIPS

ARC Target Audiences

- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)
- College (Junior-Senior)

What are Scholarships and Fellowships?

Scholarships and fellowships are grants awarded to students to financially aid them in completing degrees in science and engineering.

What are the resources necessary to begin?

Time:

Depending on the size of one's scholarship or fellowship fund, a minimum of 2 to 6 months will be needed to organize and develop the grants.

Money:

The budget for one's program will depend on the available/desirable funds within one's agency to begin a scholarship or fellowship fund.

Related Resources:

A committee of 3 to 10 people will be needed to develop and oversee the scholarship or fellowship program.

Implementation:

Follow the set of steps below for developing scholarships and fellowships. The *Directory* of *Programs and Services* contains a list of scholarship and fellowship programs to contact for more information to help make your program a success!

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Decide Whether to Contribute to Existing Scholarship and Fellowship Funds or Create One

STEP 1

If one's agency lacks the time or resources necessary to begin a new scholarship program, it may be useful to consider contributing to existing scholarship or fellowship funds. Existing programs offer one's company the advantage of having a mechanism already in place to advertise and select students and administer scholarship finances. Contact universities or even local high schools to obtain information about various scholarship and fellowship programs. Becoming involved in these existing programs is simply a matter of selecting a scholarship or fellowship fund and contributing.

Form a Scholarship or Fellowship Committee

Form a committee to help facilitate beginning a scholarship or fellowship program. Determine the number of people necessary to form the committee based on the size and amount of the scholarship fund. Established programs suggest including a minimum of three committee members. Include on the committee personnel from the agency and administrators from the schools or universities that will receive the scholarships.

The first responsibility of the committee will be to establish rules of eligibility for the scholarships and fellowships. Included within this task is defining a target audience eligible for the grants. In determining the target audience, the committee will need to consider the following points:

- Student grade level,
- Student ethnicity and gender, and
- Student grade-point average and SAT scores.

Once the target audience of the grants has been selected, other eligibility requirements must be decided upon and finalized. Example grant-eligibility requirements used by established scholarship and fellowship programs include the following:

- Students must be residents of a certain state.
- Students must be civil engineering majors.
- Students must be enrolled in certain universities.
- Students must maintain a minimum GPA throughout the grant duration.
- Students must work for the agency offering the scholarship for a minimum number of years upon completion of their degree.

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The second major responsibility of the committee will be to determine the amount and duration of each scholarship or fellowship to be awarded. If a grant is to be awarded for a period longer than one year, the committee will also need to institute a method of tracking students' academic progress. This will ensure that each student is still eligible to receive a grant after the first year. The committee will need to assign the responsibility of tracking students' progress to several of its members.

STEP 2 (Cont.)

Another primary responsibility of the committee is to oversee the scholarship or fellow-ship finances. For example, a bank will need to be selected for deposit of the scholarship funds. The committee should appoint several of its members to be responsible for managing the scholarship fund.

The last important responsibility of the committee is to select the students to be awarded grants from among the eligible applicants.

Identify an Available/Desirable Budget

After the committee has been formed, identify available/desirable funds to begin a scholarship program in one's agency. The total amount of funds available from one's agency will determine the number of grants and the amount of the grants to be awarded.



It is important to determine if the amount of money set aside by one's agency for the scholarship fund will vary from year to year. If variations in the amount of the scholarship fund occur, limit the duration of the grants awarded to only 1 year!

Contact Schools

Once the grant eligibility rules have been finalized, begin contacting students to apply for the scholarships and fellowships through schools and universities. Remember the target audience selected for the grants when contacting schools.

Some things to consider when contacting schools include

- Student grade level,
- Student ethnicity and gender,

STEP 3

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- Student interest in mathematics and science, and
- Student grade-point average. .

Send information about the scholarships and fellowships to contacted schools. Remember to include the following:

- Clearly stated eligibility requirements,
- Instructions about how to apply for the scholarships, and
- Deadlines that must be met in applying for grants.

Most established programs suggest awarding a smaller number of grants during the first year of the program. This will keep the program relatively small and manageable and give the coordinating committee a chance to deal with any problems that arise.

Implement, Then Evaluate the Program

Evaluation is critical to the program's success, since the overall impact of the grants can be assessed. As discussed previously in Step 2, student tracking should be used to evaluate the success of scholarships and fellowships. Student tracking charts the academic progress of a student from the time the grant is received until graduation. If the duration of the grants received is longer than one year, it is essential that student tracking be used to ensure that students continue to meet grant eligibility requirements (e.g., minimum GPA).

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Scholarships and Fellowships," have successful scholarship and fellowship programs. They can be contacted for more information, help, or ideas.

STEP 4 (Cont.)

RETENTION

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ACTION PLAN: CO-OP EDUCATION AND SUMMER INTERN PROGRAMS

ARC Target Audiences:

- Senior High (10-11-12)
- College (Freshman-Sophomore)
- College (Junior-Senior)

What is Co-op Education?

Co-op Education is a program in which students attend classes for half of the year (or a semester/term) and work in industry for the remainder of the year (subsequent semester/term). Students can earn money and possibly college credits while participating in a co-op program. In addition, students acquire practical experience from their technical jobs in industry that can help them to secure permanent positions in the field of engineering once they have graduated.

What are Summer Intern Programs?

Summer intern programs provide jobs to high school and college students during the summer in the field of engineering. Intern programs can also include activities like mentoring or field trips that are integrated into the programs.

What are the resources necessary to begin?

Time:

Depending on the size of one's program and the extent of the application and interviewing process, it will take approximately 6 months to 1 year to get the co-op or summer intern program started.

Money:

The budget for the program will depend on the number of co-op positions or internships one's agency offers and the corresponding salaries.

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Related Resources:

- 1. A committee of at least 10 people, including a human resource representative, engineers from one's agency, the co-op director, and several faculty from all schools and universities contacted, will be needed to design a co-op program. A committee for an internship program should contain two to three people, including a human resource representative and engineers from one's agency.
- 2. There also should be one person from the committee appointed to serve as program director.

Implementation:

Follow the set of steps below for developing co-op education and summer intern programs. The *Directory of Programs and Services* contains a list co-op education and summer intern programs to contact for more information to help make your program a success!

Form a Committee

The first step in developing a co-op education or summer intern program is to form a committee. This step is optional and depends on the size and scope of one's program. There is no need to form a comittee if two or three people can implement the program. If a committee is formed, established programs suggest including a minimum of 10 people. Initially, include a human resource representative and several engineers from one's agency.

After schools and universities have been selected to participate in the program, ask the co-op directors and several faculty of the schools or universities to join the committee. Summer intern committees only need two to three people, including a human resource representative and engineers from one's agency.

At this time, one person within the committee should be appointed to serve as program director. The director not only coordinates the program but also serves as the point of contact for questions and information about the program.

The first important responsibility of the committee is to define a target audience for the co-op or summer intern program. The target chosen audience will affect the design of the co-op or summer intern program. For example, when choosing a target audience of high school students, the program should be designed to retain the high

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school students interested in engineering and encourage them to attend college and major in engineering. However, in choosing a target audience of college students, the program should be designed to encourage students presently majoring in engineering to finish their degree and secure a permanent position in the field of engineering after graduation. In determining the target audience, the committee will need to consider the following points:

STEP 1 (Cont.)

- Student grade level,
- Student grade-point average,
- Student ethnicity and gender, and
- Student college major.

The committee will also need to decide on the eligibility requirements for the co-op and intern positions. Initially, consider the types of jobs the students will be performing before answering the following questions.

- Will a student need to be majoring in a particular branch of engineering (e.g., civil engineering) or just general engineering to perform the job?
- In order to perform job assignments, will a student need to have taken any specialized upper-level engineering classes?
- Will students be required to have a minimum GPA or previous job experience to be accepted into the co-op or internship program?
- Can a student participate in the program for more than 1 year?

Identify an Available/Desirable Budget

The next important step to designing a co-op or internship program is to identify available/desirable funds in one's agency that can be used for the program. This step will include determining the number of co-op positions or internships and salaries one's agency will offer to students. The program budget and size will vary from year to year.

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In the case of co-op programs, after specific schools and universities have been selected to participate in the program, the initial eligibility requirements may need to be modified in accordance with the co-op programs in place at the contacted schools and universities.

STEP 2 (Cont.)



Before finalizing the number of co-op positions to be offered, forecast if one's firm will have enough work and projects in the course of 6 months or 1 year to give job assignments to all of the co-op students in the program.

Contact Schools

The target audience, initial eligibility requirements, and number of co-op positions or internships available will help determine how many schools and universities to contact. Some things to consider when contacting schools include

- Student grade level,
- Studnet ethnicity and gender,
- Student grade-point average,
- Reputation of the university's engineering program, and
- Reputation of the university's co-op program.

When designing a co-op program, first compile an initial list of all the schools and universities the agency wishes to include as part of the co-op program. Next, inquire about existing co-op programs at each of the universities. Selecting schools and universities that have established co-op programs to participate in one's program will save the agency both the time and money needed to design an entire co-op program. Established co-op programs have a developed mechanism in place for selecting and placing students in co-op positions and a mechanism to deal with problems that arise. Before eliminating any schools or universities from the list, talk to some companies that have established co-op programs. Ask these companies about the universities with which their co-op program is affiliated. Networking with other companies before selecting the schools and universities will save one's agency problems in the future.

When designing an internship program, consider the reputation of the engineering programs at several universities before deciding on the final universities to be targeted.

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Design the Program

STEP 4

Co-Op Program

After narrowing down the list of schools and universities, ask the co-op director and several faculty from each of the schools to join the co-op committee. It is extremely important to ask these individuals to join the committee, because the design of the co-op program will have to be coordinated with any existing guidelines of college co-op programs. For example, the number of months a co-op student works in industry before returning to college is dictated by the semester class schedule of each university.

When designing one's co-op program, there are several issues to discuss with the committee, including:

- How many students will one's agency employ at one time?
- How many months will the students work before returning to campus?
- Will students gain college credits toward their degrees when they participate in the co-op program? How will the agency be expected to evaluate a student's work?
- How long will students participate in the co-op program with the agency (e.g., 1 year or every year while in college)?
- Will the co-op program include activities for students (e.g., mentoring programs, orientation sessions, field trips)?
- Will the agency be given a chance to recruit and interview on campus?

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Internship Program

Once the target audience and eligibility requirements have been established, the committee will need to design the summer intern program. The committee will need to decide on and plan any activities that will be included in the program. Some established programs have included the following activities in their intern programs:

- Orientation sessions for all interns,
- Field trips to other company offices or plants,
- Mentoring program matching one engineer with one intern, and
- Intern retreat during the last week of the program.

Most established programs agree that including a mentoring program in the co-op or internship program is very important. Integrating a mentoring program into a program requires pairing each student with an engineer. The engineer will act as a mentor by helping the student with job assignments, introducing the student to other engineers, and providing advice and encouragement to the student.

For more information about implementing a mentoring program:

See p. 60 of "Mentoring Programs"

After the design of the co-op or internship program has been finalized, send information about the program to the high school guidance counselors, co-op directors, and college job placement offices on the list compiled in Step 3. Remember to include

- Clearly stated job description,
- · Clearly stated eligibility requirements, and
- Instructions on how to apply for the co-op or intern positions.

Review Existing Recruiting Material

Most agencies use printed guidance material as a recruiting tool to highlight engineering job opportunities they offer. Therefore, before starting to interview qualified applicants for the co-op or intern positions, take some time to review the agency's career information (e.g., brochures, videos, posters). In order to recruit the best students for one's program, the guidance materials will have to be informative and professional.

STEP 4 (Cont.)

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First, check the following list of "essential elements" to be included in all printed guidance material (3). Try to identify in these materials which elements are lacking and those that must be added or updated.

STEP 5 (Cont.)

Career information must be accurate (current) and provide the following:

- Definition of civil engineering and its subdiscipline areas
- Salary structure (short-term and long-term)
- Working environment (office and field)
- Advancement potential (managerial, technical, and entrepreneurial opportunities)
- Education requirements

For more information about evaluating existing recruiting materials:

See p. 33 of "Printed Guidance Materials"

Interview Candidates

STEP 6

Following the student application deadline for the program, the committee, with the help of a human resource representative from one's agency, should begin to evaluate the applications. Next, a preliminary list of qualified applicants can be compiled. Before the final selection of students to fill the co-op or intern positions, eligible candidates will need to be interviewed by the human resource representative on one's committee or by other committee members. Most universities have a mechanism in place to conduct the interviews on campus.

For more information about interviewing and recruiting in schools and on college campuses:

See Chapters 3 and 4 of the AASHTO Recruitment and Retention Guide.

Regionation

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Implement, Then Evaluate the Program

STEP 7

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success.

- Problems in one's co-op or intern program can be detected and corrected as soon as they occur.
- The effectiveness of any activities included in one's program (e.g., a mentoring program) can be evaluated so that improvements can be made.
- The overall impact of the program can be assessed.

Extensive program evaluation will be possible for a co-op or summer intern program, since the agency will hire a relatively small number of students. Solicit opinions about the positive and negative aspects of one's program from the students by using entry and exit interviews or before and after questionnaires.

It is important to perform an evaluation at both the beginning and the end of the program. Comparing the information from the evaluations will illustrate any changes in the students' attitudes or opinions about an engineering career as a result of participation in the program.

In addition to interviews or questionnaires, student tracking should also be used to determine if the students in one's program actually graduate with a degree in engineering. Student tracking charts the academic progress of a student from the time the student participates in the co-op or intern program until graduation.

Depending on the schools or universities with which one's co-op program is affiliated, additional student evaluations such as supervisors' reviews may be required.

Also, if additional activities were integrated into the co-op or summer intern program, separate evaluations should be performed for each activity. For example, if a mentoring program is integrated into the program, further evaluation of the mentoring program should be performed.

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For more information about evaluating a mentoring program:

See p. 60 of "Mentoring Programs"

STEP
7
(Cont.)

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Co-Op Education and Summer Intern Programs," have successful co-op and summer intern programs. They can be contacted for more information, help, or ideas.

CHAPTER 5

CURRICULUM PROGRAMS

Research from Phases I and II indicates that civil engineering lacks image—in other words, personality. Students, especially at pre-college levels, fail to grasp the relevancy of their mathematics and science courses. Yet, the importance of the teacher as an influencer cannot be understated. Drawing on these observations, curriculum modifications through the pre-college and college experience are warranted. This is a long-term process that will require the cooperation of engineers, educators, administrators, school boards, parents, counselors, and curriculum developers (3).

The curriculum at the pre-college stage can be modified (3) through the following:

- 1. Development of a more creative and cohesive mathematics and science curriculum that integrates the relevancy of the subject material;
- 2. Development of curriculum materials that illustrate how mathematics and science integrate with social concerns in solving civil-engineering-related problems; and

3. Incorporation of the importance of mathematics and science preparedness.

The curriculum at the college stage can be modified (3) in several areas, such as

- 1. Provision of early exposure to the engineering profession and its specialties,
- 2. Provision of early and intensive exposure to civil engineering and its specialties, and
- 3. Emphasis on strong preparation in oral and written communication skills.

Curriculum programs in this manual are applicable to students in grades K-12 and college and include Teacher Workshops, Curriculum Enrichment Programs, Summer Workshops, and Pre-College Programs. Curriculum programs involve collaboration among engineers, transportation professionals, engineering faculty, and teachers to develop appropriate materials that show the relevancy of mathematics and science to engineering.

RETENTION

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ACTION PLAN: CURRICULUM ENRICHMENT PROGRAMS

ARC Target Audiences

- Elementary (K-6)
- Junior High (7-8-9)
- Senior High (10-11-12)
- College (Freshman-Sophomore)
- College (Junior-Senior)

What are Curriculum Enrichment Programs?

Curriculum enrichment programs can include conferences (Math and Science Network conferences), enrichment classes ("Saturday Tutorial and Enrichment Program" - PRIME), classroom kits (Mineral Information Institute kits), and college classes (Freshman Engineering Classes - Cornell University and Penn State). Research has found that even at the elementary level, students desire more practical examples in their classes that demonstrate the relevancy of mathematics and science. However, many teachers have difficulty relating their subject to the world of technology (3). Curriculum enrichment programs involve collaboration among engineers, curriculum writers, and teachers to develop appropriate materials that show the relevancy of mathematics and science to engineering.

What are the resources necessary to begin?

Time:

Depending on the size and type of curriculum program, about 6 months to 3 years will be needed to organize and design the program. (Curriculum classroom kits can require up to 3 years to develop, design, test, refine, and distribute.)

Money:

The budget for the program will also depend on the type of curriculum program. Some established curriculum programs are funded through grants from the National Science Foundation or other foundations. Developing classroom kits often requires the use of professional artists and writers;

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costs have been reported between \$950,000 and \$2 million for established programs. Curriculum programs, like FACETS of the American Chemical Society, also require large budgets to develop new mathematics or science curriculums. Some enrichment classes, not held during school hours (like PRIME's "Saturday Tutorial and Enrichment Program"), pay salaries to the teachers who participate in the program.

Smaller-scale curriculum development programs are also possible. For example, an engineer can work with a teacher once a month to develop a lesson for a mathematics or science class that incorporates an engineering problem into the curriculum.

Related Resources:

- 1 Large-scale curriculum development programs need the input of a large group of people including school administrators, education experts, teachers, and engineers from industry.
- 2. Large-scale curriculum development programs will also require the services of professional writers and artists to develop new curriculum materials for classrooms.
- 3. Smaller-scale curriculum activities may require only the expenses associated with the materials needed for the in-class instruction.

Implementation:

Follow the set of steps below for developing curriculum enrichment programs. Specific notes about the different types of curriculum programs are included in the steps as appropriate. The *Directory of Programs and Services* contains a list of curriculum enrichment programs to contact for more information to help make your program a success!

RETENTION

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Form a Curriculum Enrichment Committee

STEP 1

This step is optional and depends on the size and scope of the desired curriculum development program. A large-scale curriculum development program will involve numerous people. It is to one's advantage to form a committee of at least 10 people to help divide the program responsibilities. Different subcommittees can be formed for fund raising, interviewing and hiring writers and artists, reviewing different materials, and so on. One person within the committee should be appointed to serve as program director. The director not only coordinates the program, but also serves as the point of contact for questions and information about the program.

For a curriculum program with a smaller size and scope, a committee need not be formed. Program design and management can be accomplished by a program director and one or two assistants, including a teacher or school administrator.



Established programs have stated that it is crucial to gain support for one's curriculum program from school administrators and teachers from the very beginning. Without this support, it is doubtful that the curriculum program will be implemented.

Select the Target Audience for the Program

Whether or not a program committee was formed in Step 1, a target audience must be selected for the curriculum development program. The target audience should be as specific as possible since the audience will influence the activities and academic content of the program. For example, PRIME targeted average-GPA senior high school students for the "Saturday Tutorial and Enrichment Program (11)." On Saturday mornings, students bring any problems with their mathematics and science homework to a college where they can be tutored and helped by high school teachers. The purpose of this program is to encourage average students to continue enrolling in mathematics and science classes throughout high school.

Curriculum programs can target any student group from K-12th grade and from freshman through senior level in college. In determining the target audience, the committee will need to consider the following points:

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- Student grade level,
- Student grade-point average,
- · Student ethnicity and gender, and
- Student college major.

Set Program Goals

Before the curriculum program can be designed, it is important for the committee or the program director to define the program goals. The academic content and activities of the program will be chosen to meet the goals selected in this step. There are two types of goals that can be defined for each program: behavioral goals and attitudinal goals. The effect of a behavioral goal is a change in behavior and the effect of an attitudinal goal is a change in attitude. The committee or program director can define one goal or several goals depending on the size and scope of the program.

Following are example goals from established curriculum programs:

- The main attitudinal goal for SAE International's "World in Motion" classroom curriculum kits is to provide students with a more positive attitude about studying mathematics and science.
- The main behavioral goal behind the American Chemical Society's "Pre-High School Science" program is to encourage teachers, through the new program curriculum materials, to use more hands-on science activities in the pre-high school classroom.

Develop the Curriculum Enrichment Program

The first step to designing a curriculum enrichment program is to choose a program format. The format will depend on the proposed size and scope of one's program, as well as the target audience. Budgetary constraints might also limit the options available for curriculum program formats. Sample curriculum formats and programs include the following:

Conference

"Expanding Your Horizon Conferences" - Math and Science Network

STEP 2

(Cont.)

STEP 3

RETENTION

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For more information about the curriculum format of a conference program:

See p. 21 of "Conferences"

STEP 4 (Cont.)

Classroom Kits

"Mineral Information Institute" - Society for Mining, Metallurgy, and Exploration, Inc.
"World in Motion" - SAE International

Classroom kits are essentially boxes that contain different lessons and activities related to mathematics and science. The lessons can be designed to be used by individual students or groups of students, or they can be presented to the entire class by the teacher. The "Mineral Information Institute" kits contain reference books and sample rocks so the kits are entirely self-sufficient. Everything the teacher needs, including reference material, is contained in the kit. However, the "World in Motion" kits were designed to be used by an engineer and a teacher. The engineer works with the teacher on each lesson to provide support and additional technical information.

Classroom kits are expensive and time-consuming to produce. The examples cited above required budgets of \$1 million to \$3 million and a time period of 3 to 4 years to produce. Professional writers and artists were contracted to produce the kits with the input of education experts. The kits were also field tested and revised before being mass produced.

Established programs have emphasized the importance of holding orientation sessions to show teachers how to use classroom kits and other curriculum materials properly. The more comfortable teachers feel with new curriculum materials, the more likely they are to use the materials in the classroom.

Enrichment Classes

"Academic Year Program," "Saturday Tutorial and Enrichment Program" - PRIME

Enrichment classes can be either integrated into mathematics and science classes during school hours or held after school or on the weekends. These classes are designed to demonstrate the relevancy of mathematics and science to the field of engineering. The classes can also offer extra mathematics and science help to students, as in the case of PRIME's "Saturday Tutorial and Enrichment Program."

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The size and scope of enrichment classes varies among established programs. Enrichment classes can be as simple as an engineer working with a teacher once a month to plan a mathematics or science lesson that relates to engineering. The budgets for enrichment programs are quite small compared to those required for classroom kits. The primary expenditures will be for materials for activities included in the program or salaries for teachers participating in the program after school hours.

STEP 4 (Cont.)

College classes can be included in the category of enrichment classes. Several colleges have freshman seminar classes that introduce students to engineering in general as well as to the different disciplines in engineering. Requirements to develop a new class vary from university to university. The major resource necessary to develop this type of program is a faculty member willing to design and teach the course.

After choosing a preliminary program format, conduct some research about existing curriculum programs of the same format. Specifically, examine the activities and academic content of the established programs. The purpose of this exercise is to find an existing program model that can be adapted to fit one's goals and audience. One's agency will save a great deal of time and resources by adapting an existing curriculum program model to one's situation rather than designing an entirely new program.

STEP

5

Identify an Available/Desirable Budget and Recruit **Outside Sponsors**

The budget required for the curriculum enrichment program will depend on the size. scope, and format of the program as well as the resources available. Contracting outside help from writers, artists, and education experts to help develop the curriculum program is a large budget expenditure. Established programs suggest gaining the support, input, and participation of local school districts, teachers, and administrators during program development. This involvement will decrease or alleviate the need for smaller programs to contract outside resources to develop the program.

Another large curriculum program expenditure is teacher salaries for programs that are conducted after school hours. This problem can be alleviated by integrating one's curriculum enrichment program into the school curriculum by working closely with teachers and school administrators during the program development. This option will not work unless the agency can gain support from local school districts.

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A possible source of funding for curriculum enrichment programs is foundation grants (e.g., National Science Foundation grants) (8). If one's agency is considering applying for a grant, try to enlist the help of someone familiar with writing a grant proposal. Consult the established programs listed in the *Directory of Programs and Services* for more information about grants.

STEP 5 (Cont.)

The final decision that the agency will need to make during this step is whether or not outside sponsors will need to be recruited. Soliciting corporate sponsors is a very time-consuming task, and the benefits should be weighed carefully against the time expended.

For more information about recruiting corporate sponsors:

See p. 23 of "Conferences"

If one's agency cannot acquire the resources to support the curriculum enrichment program designed in Step 4, redesign the program based on the funds from the above step. For example, scale down the program to make it fit the available funds. Most established programs have commented that designing a curriculum program is an iterative process between Steps 3 and 4 that requires several tries before a successful balance is achieved.

Recruit Teachers to Participate in the Program

Now that the curriculum enrichment program has been designed and the budget has been finalized, recruit teachers to participate in the program. If one's agency has included teachers and school administrators in the program development and has gained the support of local school districts, recruiting teachers to participate should not be a problem. However, if this is not the case, personal contact should be used to contact schools and teachers. Send members of the committee or the program director to local schools to meet with principals and mathematics and science teachers to discuss one's curriculum program.



If teachers or school administrators have not participated in developing the curriculum program, it may be difficult to get the program integrated into the school curriculum. Modifications to the existing program may need to be made.

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Generally, teachers who are enthusiastic about the curriculum program and volunteer to participate will remain with the program longer than teachers who are forced to participate by a principal or school administrator. Some established programs will not work with a school unless the principal and teachers have demonstrated support for the program.

STEP 6 (Cont.)

STEP 7

Implement, Then Evaluate the Program

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success:

- Problems in one's curriculum program can be detected and corrected as soon as they occur.
- The effectiveness of one's curriculum materials can be evaluated so that improvements can be made next time.
- The overall impact of the program can be assessed.

Curriculum materials will need to be field tested and revised before they are mass produced and distributed. This is especially true for the lessons in curriculum classroom kits.

The easiest and most efficient method of evaluation is a questionnaire. Solicit both positive and negative comments about the curriculum program and the curriculum materials from teachers and students. Ask specific questions about the curriculum materials included in the program (e.g., which materials did students like best?, etc.).

Follow-up questionnaires should also be used in curriculum enrichment programs. Questionnaires should be mailed about 6 months after the program or curriculum materials were distributed to all teachers who participated in the program. The information from these questionnaires will reveal whether teachers are still using their classroom kit or curriculum materials.

RETENTION

CURRICULUM

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Curriculum Enrichment Programs," have implemented successful curriculum enrichment programs. They can be contacted for more information, help, or ideas.

RETENTION

CURRICULUM

ACTION PLAN: SUMMER WORKSHOPS AND SUMMER PRE-COLLEGE PROGRAMS

ARC Target Audiences

- Elementary (K-6)
- Junior High (7-8-9)
- Senior High (10-11-12)

What are Summer Workshops?

Summer workshop programs target elementary and junior high school students and are designed to encourage students to pursue studies in engineering and related fields. Activities in these workshops are hands-on and all engineering concepts are presented very simply and generally. The duration of the workshops is generally 1 to 2 weeks.

What are Summer Pre-College Programs?

Summer pre-college programs target senior high school students and emphasize a more academic approach to preparing students for college. Activities presented in these programs demonstrate advanced mathematics, science, or computer concepts in order to prepare students for entry into their critical freshman year in engineering and related fields. Career planning workshops and college financial aid workshops may also be included. Most of these programs are held at colleges and universities.

What are the resources necessary to begin?

Time:

Depending on the size and scope of one's workshop or program, about 8 months to 1 year will be needed to organize and design the program.

Money:

The budget for one's program will depend on several factors. Room and board will be the principal expenditure and must be included in the budget for each student if the summer workshop or summer pre-college program is being held at a university.

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The amount of money budgeted for each student will depend on whether a program registration fee is charged to each student (e.g., the student may be required to pay half of the room and board fees to attend the workshop). If one's agency has decided to sponsor the entire program or workshop, established programs suggest budgeting about \$500 per week per student for room and board on a college campus. Other expenses incurred by these programs include materials needed for hands-on workshops and fees paid to lab assistants to participate in the program.

Related Resources:

A committee of several people, including engineers from the agency, school administrators, and mathematics and science teachers will be needed to design the program.

Implementation:

Follow the set of steps below for developing a summer workshop or a summer pre-college program. The steps to organize and design both types of programs are similar. The largest difference between the two types of programs is the types of activities included in each of the programs. Specific notes about any program differences have been added to the steps as appropriate. The *Directory of Programs and Services* contains a list of summer workshops and summer pre-college programs to contact for more information to help make your program a success!

Form a Summer Workshop or Summer Pre-College Committee

STEP 1

Begin designing a summer workshop or summer pre-college program by first forming a committee. This step is optional and depends on the size and scope of the program. Established programs suggest including about 10 people on the committee. Include engineers from industry, university engineering and education faculty, and school administrators. Also remember to include elementary and junior high school mathematics and science teachers for summer workshops, or senior high school mathematics and science teachers for summer pre-college programs.

For a summer workshop or summer pre-college program of a smaller size and scope, a committee need not be formed. Program design and management can be accomplished by a program director and one or two assistants, including a teacher or school administrator.

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At this time, one person within the committee should be appointed to serve as program director. The director not only coordinates the program, but also serves as the point of contact for questions and information about the program.

STEP 1 (Cont.)

The first important responsibility of the committee is to define a target audience for the program. The selected target audience should be as specific as possible. The chosen audience will affect the design of the activities in the program and whether the program will be a summer workshop or a summer pre-college program. For example, a summer workshop targeting an audience of elementary and junior high school students will need to contain mathematics and science activities that are handson and fun-oriented. Any engineering concepts in the activities will need to be presented simply and very generally. In contrast, a summer pre-college program targeting an audience of senior high school students who have been accepted into college may contain classes in advanced mathematics, science, or computer topics to prepare students for their freshman year in college. A summer pre-college program targeting an audience of students about to enter their senior year in high school may contain college planning workshops and financial aid workshops. In determining the target audience, the committee will need to consider the following points:

- Student grade level,
- Student grade-point average,
- Student ethnicity and gender,
- Student college major, and
- Student interest in mathematics and science.

Other committee responsibilities will include

- Establishing goals for the program,
- Developing a budget and deciding if fund raising will be necessary,
- Offering suggestions about activities and program content, and
- Establishing program eligibility requirements and selecting students for the program from the qualified applicants.

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Develop Goals for the Program

STEP 2

Before either program can be designed, it is important for the committee to define the goals of the summer workshop or summer pre-college program. All of the activities included in the program will be chosen to meet the goals selected in this step. Since the target audiences of these programs are different, the goals of the programs will also be different. There are two types of goals that can be defined for each program: behavioral goals and attitudinal goals. The effect of a behavioral goal is a change in behavior and the effect of an attitudinal goal is a change in attitude. The committee can define one goal or several goals depending on the size and scope of one's program.

An example of an attitudinal goal for summer workshops is that after the workshop, students will have a more positive attitude about studying mathematics and science. An example behavioral goal for summer workshops is that after the workshop, students will continue to enroll in mathematics and science classes throughout junior and senior high school.

An attitudinal goal for summer pre-college programs might be that after the program, students will have an understanding and appreciation of the jobs that engineers perform. An example behavioral goal for summer pre-college programs is that as a result of the program, students will improve their mathematics, science, and computer skills before entering their freshman year in college.

Design the Summer Workshop or the Summer Pre-College Program

The design of the summer workshop or summer pre-college program will depend heavily on the target audience selected in Step 1 and the goals selected in Step 2. Before designing any of the activities of the program, conduct some research about existing summer workshop or summer pre-college programs. Specifically, examine the formats and activities utilized by established programs. The purpose of this exercise is to find an existing program model that can be adapted to fit one's own goals and audience. The committee will save a great deal of time and resources by adapting an existing model to the situation rather than designing a program from scratch. At the very least, established programs should be able to provide the committee with activity ideas that have been successful and the names of potential program speakers.

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The activities planned for the workshop or program should be closely coordinated with the goals chosen in Step 2.

STEP 3 (Cont.)



The types of activities included in summer workshops and summer pre-college programs are very different!

Summer workshops targeting elementary or junior high school students should contain mathematics and science activities that are hands-on and fun-oriented. Engineering concepts can only be presented very simply and generally. Students can be introduced to the general field of engineering and the jobs engineers perform. A decision has to be made by the committee on which disciplines and how many disciplines to introduce and include in the program. However, research has shown that the elementary and junior high school years are too early for specific career planning. The emphasis of summer workshops should be to encourage students to continue to enroll in mathematics and science classes.

Summer pre-college programs should include activities that emphasize a more academic approach to preparing students for college. Activities may include advanced mathematics, science, or computer classes that will help prepare students for entry into their critical freshman year in engineering and related fields. Research-related activities can also be used in pre-college programs to improve students' mathematics, science, and computer skills. Other activities that can be included in pre-college programs are study skills workshops, financial aid workshops, and career planning workshops.

Some established summer workshops and summer pre-college programs include mentoring in their design. Integrating a mentoring program into a workshop or pre-college program requires pairing each student or a small group of two or three students with an engineer from one's agency, an engineering faculty member at the university, or even an engineering college student. The engineer will act as a mentor by helping the student with program activities or providing information about the type of job an engineer performs. Most established programs encourage mentors to remain in contact with their student after the program is over to continue to offer support, encouragement, and advice to the student.

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For more information about implementing a mentoring program: See p. 60 of "Mentoring Programs"

STEP 3 (Cont.)

The design of the summer workshop or summer pre-college program includes determining the duration of the program. Most established summer workshop programs are 1 to 2 weeks in length. However, summer pre-college programs are 2 to 10 weeks in length. This difference is because the activities for senior high school students are more complex and require longer time periods for program completion. These program durations are useful as general guidelines; the final decision for the length of one's program will be based on available facilities and budget.

Develop a Budget and Recruit Outside Sponsors

The budget required for the summer workshop or summer pre-college program will depend on the size and the scope of the program and the resources available. Since most workshop and pre-college programs are conducted at universities, room and board for each student will be the agency's primary expenditure. Established programs suggest budgeting \$500 per student per week. This number is an approximation and will vary depending upon the university. The committee should also decide during this step whether a registration fee from workshop or pre-college participants will be deemed necessary. For example, this fee could be used to pay a portion of each student's room and board. If collecting a fee is deemed necessary, remember to keep it as small as possible. Established programs have commented that charging a registration fee forces students and parents to make a commitment to attend the workshop or program (7).

If students be will staying overnight in college dormitories during the program, resident assistants will be needed to oversee the students. Elementary and junior high school students will need close supervision and will require more resident assistants than senior high school students. Resident assistant arrangements will need to be made with the university. Some universities can provide resident assistants and the cost is already figured into the student's room and board. In some cases, resident assistant salaries will need to be figured as a separate item in the program budget.

If the program budget will not allow the expense of room and board for students at a university, another option is to hold the program activities during the day at a university or at one's agency (depending on the number of students). This option will greatly decrease the size of the required budget. However, when publicizing the program, remember to only target students who live within a reasonable distance of the program facility.

RETENTION



Established programs suggest having the committee construct an additional list of materials necessary for the program activities and their cost. Next, the resources available to the committee can be used to acquire many of the items through donations. For example, a school administrator could donate clerical help for mailing program applications and acceptance letters.

STEP. 4 (Cont.)

The final decision that the committee will need to make during this step is whether or not outside sponsors will need to be recruited. Soliciting corporate sponsors is a very time-consuming task and the benefits should be weighed carefully against the time expended.

For more information about recruiting corporate sponsors:

See p. 23 of "Conferences"

The Pennsylvania State University's summer workshop "Ms. Wiz" has demonstrated another successful approach to recruiting sponsors. Letters are sent each year to faculty members in engineering and related fields at Penn State. The letters ask each faculty member to pledge enough money to sponsor one student so that they can attend the workshop. The pledge covers 2 weeks' room and board for one student. The letters also ask for faculty to volunteer as mentors. This approach for soliciting sponsors can easily be adapted to fit large organizations and agencies.

If the necessary resources cannot be acquired to carry out the workshop or pre-college program designed in Step 3, redesign the program based on the funds from the above step. Most established programs have commented that designing a workshop or pre-college program is an iterative process between Steps 3 and 4 that requires several tries before a successful balance is achieved.

Recruit Volunteers

STEP

5

The number of speakers that need to be recruited depends on the duration of the program and the number of activities planned. The type of speakers the committee will need to recruit for the program depends on the goals of the program and the activities planned. For example, either senior high school mathematics and science teachers or university faculty will need to be recruited to teach enrichment mathematics and science classes for summer pre-college programs. If the summer workshop will include hands-

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on mathematics and science activities, recruit teachers familiar with the activities to participate in the program. Another option is to have the teachers familiar with different hands-on activities show engineers from one's agency how to conduct the activities.

Ask for suggestions from the committee about possible workshop or pre-college program speakers. Use the committee members' corporate contacts to recruit speakers. Established programs also suggest contacting colleges and professional societies for names and recommendations of possible speakers. Personal contact is the key to recruiting volunteer speakers. However, education experts or university faculty may need to be offered a salary to participate, especially for programs that run over several weeks.

Publicity for the Program

There are two different ways to publicize one's summer workshop or summer precollege program: personal contact and the media. Personal contact is accomplished through the committee members spreading the word about the workshop or precollege program to school administrators and school contacts. Several members of the committee should also be appointed to personally contact mathematics and science teachers at local schools and provide them with information about the program. Remember to include:

- Clearly stated eligibility requirements
- Instructions on how to apply for the program
- Application deadlines and registration fees

The media, specifically radio and newspapers, can also be used to publicize the summer workshop or summer pre-college program to the community.

Implement, Then Evaluate the Program

Why is evaluation so important?

There are several reasons why evaluation is critical to the success of one's summer workshop or summer pre-college program:

STEP 5 (Cont.)

STEP

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- Problems in one's program can be detected and corrected as soon as they occur.
- The effectiveness of hands-on activities can be evaluated so that improvements can be made.
- The effectiveness of enrichment classes can be evaluated so that improvements can be made.
- The overall impact of the program can be assessed.

The easiest and most efficient way to evaluate a summer workshop or summer precollege program is through pre- and post-program questionnaires. Students should be asked to fill out a pre-program questionnaire when they register, before any part of the program begins. The post-questionnaires can be filled out on the last day of the program. Solicit both positive and negative aspects of the program. Comparing the information from the evaluations will illustrate any changes in the students' attitudes or opinions about mathematics, science, and engineering as a result of participating in the program.

Short questionnaires can also be used after each activity in the program to gain a more detailed evaluation of the activities. If a mentoring program is integrated into the summer workshop or summer pre-college program, a further evaluation of the mentoring program should be performed.

At the end of the program, questionnaires should also be distributed to program speakers and committee members to solicit their opinions about the workshop or pre-college program.

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Summer Workshops and Summer Pre-College Programs," have successful summer workshops and summer pre-college programs. They can be contacted for more information, help, or ideas.

STEP 7 (Cont.)

RETENTION

CURRICULUM

ACTION PLAN: TEACHER WORKSHOPS

ARC Target Audiences

- Elementary (K-6) Teachers
- Junior High (7-8-9) Teachers
- Senior High (10-11-12) Teachers

What are Teacher Workshops?

Teacher workshops are programs designed primarily for K-12 mathematics and science teachers. These workshops can have a number of purposes, including giving teachers a better understanding and appreciation of the jobs engineers perform and also showing teachers how to incorporate more hands-on mathematics and science activities into their classes. The workshops can range in length from 1 day to several weeks.

What are the resources necessary to begin?

Time:

Depending on the size and duration of one's workshop and the activities planned, a minimum of 6 to 8 months will be needed to plan and develop the teacher workshop.

Money:

The budget needed for one's workshop will depend on the size and scope of the program as well as the resources available. Existing program budgets vary widely. For example, some teacher workshop programs have developed kits as teaching aides and as a way to encourage teachers to incorporate more hands-on mathematics and science activities into their classes. The cost for creating and producing these kits can reach millions of dollars. At the other extreme, the greatest budgetary expense for some programs has been the cost of renting a facility in which to hold the workshop. Other typical workshop expenditures will include materials needed for hands-on activities and lunch for the participants (optional). An approximate estimate for the cost of a workshop is between \$3,000 and \$4,000.

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Related Resources:

- 1. A committee of about 10 people, including teachers and administrators, as well as professional engineers, will be needed to design the teacher workshops.
- 2. One person from the committee must be appointed to serve as the program director.
- 3. Depending on the types of activities included in the workshop, different workshop speakers will also need to be recruited.

Implementation:

Follow the set of steps below for developing teacher workshops. The *Directory of Programs and Services* contains a list of teacher workshops to contact for more information to help make your program a success!

Form a Committee

STEP 1

The committee will be making key decisions that will ultimately determine the success of one's workshop. For this reason, it is important to choose the members of the committee carefully. Try to gain support for the program from school districts and administrators in one's area. For this reason, include at least 10 people on the committee, including local mathematics and science teachers, school administrators, guidance counselors, and professional engineers from industry.

Immediately after forming the committee, appoint one person to serve as program director. The director not only coordinates the program but also serves as the point of contact for questions and information about the program.

The first responsibility of the committee will be to select the target audience of the teacher workshop. The target audience chosen will affect the design and goals of the teacher workshop. For this reason, one of three main target audiences will need to be chosen: elementary (K-6) teachers; junior high (7-8-9) teachers; or senior high (10-11-12) teachers. After one of these groups is selected, the target audience will need to be further narrowed down. For example, decide whether to include both mathematics and science teachers or just mathematics or science teachers. These decisions may be based on one's budget and on the group of teachers that supported the program and are likely to participate.

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Remember that even though one's immediate target audience is teachers, the ultimate target audience will be elementary, junior high, or senior high school students.

STEP

1
(Cont.)

Other committee responsibilities will include

- Establishing goals for the workshop,
- · Developing a budget and deciding if fund raising will be necessary, and
- Offering suggestions about workshop content.

STEP 2

Develop Goals for the Workshop

Before the content of the workshop can be developed, it is important for the committee to define the goals of the teacher workshop. There are two different types of goals that can be defined: behavioral goals and attitudinal goals. The effect of a behavioral goal is a change in behavior and the effect of an attitudinal goal is a change in attitude. The committee can define one goal or several goals depending on the size and scope of one's workshop.

An example attitudinal goal for teacher workshops is that after the workshop, teachers will have an understanding and appreciation of the jobs engineers perform. In other words, teachers will have a positive attitude toward engineering.

Example behavioral goals for teacher workshops are that after the workshop, teachers will incorporate more hands-on mathematics and science activities into their classes or incorporate some engineering problems using mathematics and science into their classes.

Design the Workshop

The design of the workshop will depend primarily on the target audience selected in Step 1 and the goals selected in Step 2. Two important issues that one's committee will need to address are

- What will be the duration of the workshop (i.e., 1 afternoon, 1 day, or all week)?
- When will the workshop take place (i.e., during the summer or during the academic year)?

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If the workshop is to be held during the academic year, a workshop of 2 days is feasible. Because school is not in session during the summer months, summer workshops can be longer in duration.

STEP 3 (Cont.)

Before beginning the actual design of one's workshop, do some research about existing teacher workshop programs. Review different formats of established programs and their related activities. Do not design an entire workshop program from scratch if there is an existing workshop model that can be adapted to one's program. At the very least, established programs should be able to provide the committee with activity ideas that have been successful.

The activities planned for the workshop should closely match one's program goals. For example, if the attitudinal goal were to give teachers an understanding and appreciation of the jobs engineers perform, it would be appropriate to have several engineers from one's agency volunteer to make presentations about the jobs they perform and any recent technological advances the agency has made. Another activity that supports this goal is giving the teachers in the workshop a tour of the agency and demonstrating how mathematics and science are used to solve engineering problems.

For more information about getting engineers involved in making presentations:

See p. 42 of "School Presentations"

Established programs have found that a very effective element in the workshops has been introducing teachers to hands-on mathematics and science activities. Hands-on activities are designed to stimulate the students' interest in scientific or technical areas or to help them broaden their image of mathematics. These activities provide teachers and students with an experience as well as an awareness of how these disciplines relate to the outside world. Begin designing hands-on workshops by consulting with established workshop programs to gain ideas for successful hands-on activities.

Develop a Budget and Recruit Outside Sponsors

As stated previously, the budget required for one's workshop will depend on the size and scope of the workshop and the resources available. Established programs suggest having one's committee construct a list of the materials necessary for the workshop and their

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cost. Next, the resources available to the committee can be used to acquire many items through donations. Consider the type of facility required in which to hold the workshop, including the number of rooms that will be needed and any special equipment the facility will have to provide. Next, use the committee's resources to try and get a facility donated. For example, a school administrator could donate the high school facilities for a Saturday afternoon. Another option is to hold the workshop in a conference room at one's agency. This option may only be feasible for small workshops.

STEP 4 (Cont.)

The committee should also decide if a registration fee from teacher workshop participants will be required. If collecting a fee is necessary, remember to keep it small. Established programs have indicated that charging a registration fee is a good idea since it forces teachers or school districts to make a commitment to attend the conference (7).

The final decision that the committee will need to make during this step is whether or not outside sponsors will need to be recruited. Soliciting corporate sponsors is a very time-consuming task and the benefits should be weighed carefully against the anticipated time required.

For more information about recruiting corporate sponsors:

See p. 22 of "Conferences"

If the resources cannot be acquired to carry out the workshop designed in Step 3, redesign the workshop based on the funds from the above step. Established programs note that designing a workshop and a budget is an iterative process between Steps 3 and 4. Several attempts may be necessary before a successful balance is achieved.

Recruit Volunteers

STEP 5

The number of speakers that will need to be recruited depends on the duration of one's workshop and the number of activities planned. The type of speakers the committee will need to recruit for the workshop depends on the goals of the program and the activities planned. For example, if the goal of the workshop is to help teachers appreciate the types of jobs engineers perform, it may be useful to recruit engineers in one's agency to make presentations or give tours. Remember to include women and minority engineer role models as workshop speakers. If the workshop will include demonstrations of hands-on mathematics and science activities, it is a good idea to recruit either teachers familiar with the activities or education experts to participate in the workshop.

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Ask for suggestions from the committee about possible conference speakers. Use the committee members' contacts to recruit speakers. Established workshops also suggest contacting colleges and professional societies for names and recommendations of possible speakers. Personal contact is the key to recruiting volunteer speakers. However, education experts or teachers may need to be offered monetary incentives in the program.

STEP 5 (Cont.)

STEP 6

Publicity for the Workshop

Before contacting individual schools to inform teachers about the workshop program, talk to the superintendents of several school districts and the teacher's union. Gaining the support and endorsement of these two groups is important and will encourage more teachers to participate. In addition, if the workshop is held during the academic year, the superintendent can give teachers incentives (e.g., paid time off) to participate.

Two of the most straightforward methods to publicize one's workshop are through word of mouth by the teachers on the committee and through contacting individual schools.

When sending information about one's teacher workshop to individual schools, appoint members of the committee to make follow-up telephone calls to the mathematics and science teachers at the targeted grade level of the schools. Remember to include the following in the information sent to schools:

- Target audience of the workshop,
- · Complete description of the workshop and workshop goals, and
- Registration fees and deadlines.

STEP 7

Implement, Then Evaluate the Workshop

Why is evaluation so important?

There are several reasons why evaluation is critical to a program's success:

- Problems in one's workshop can be detected and corrected as soon as they
 occur.
- The effectiveness of one's hands-on workshops can be evaluated so that improvements can be made next time.
- The overall impact of the workshop can be assessed.

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The easiest and most efficient method of evaluation is a questionnaire. Solicit both positive and negative aspects of the workshop from teachers and speakers. Ask specific questions about hands-on activities that were included in the workshop--which activity did they like, will they use hands-on activities in their classes, and so on.

STEP
7
(Cont.)

If attitudinal goals are included in the goals of the workshop, it is extremely important to perform a pre-workshop and a post-workshop evaluation. Teachers should be asked to fill out the pre-workshop questionnaire when they register, before any part of the workshop begins. The post-workshop questionnaire can be filled out at the end of the workshop. Comparing the information from the evaluations will illustrate any changes in the teachers' attitudes or opinions about engineering as a result of participating in the workshop.

If behavioral goals are included in the goals of the workshop, follow-up questionnaires should also be used in teacher workshop programs. Questionnaires should be mailed about 6 months after the program to all the teachers who participated in the workshops. The information gained from these questionnaires will help to illustrate what strategies learned by the teachers at the workshop have been implemented in their classes.

Need more information?

The agencies listed within the *Directory of Programs and Services*, "Teacher Workshops," have successful teacher workshop programs. They can be contacted for more information, help, or ideas.

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