CHANGING THE CONVERSATION

MESSAGES FOR IMPROVING PUBLIC UNDERSTANDING OF ENGINEERING

Committee on Public Understanding of Engineering Messages

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C,
www.nap.edu

NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001

This study was supported by Contract/Grant No. ENG-0550368 between the National Academy of Sciences and the National Science Foundation and by grants from the Georgia Institute of Technology and S.D. Bechtel, Jr. Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

Library of Congress Cataloging-in-Publication Data

Changing the conversation : messages for improving public understanding of engineering / Committee on Public Understanding of Engineering Messages.
p. cm.
Includes bibliographical references.
ISBN 978-0-309-11934-4 (pbk.) — ISBN 978-0-309-11935-1 (pdf) 1. Engineering—United States. 2. Engineering—Social aspects—United States. 3. Engineers—United States—Public opinion. I. National Academy of Engineering. Committee on Public Understanding of Engineering Messages.
TA160.4.C53 2008
620.00973—dc22
2008016992

Copies of this report are available from National Academy Press, 500 Fifth Street, N.W., Lockbox 285, Washington, D.C. 20055; (800) 624-6242 or (202) 334-3313 (in the Washington metropolitan area); online at http://www.nap.edu

Printed in the United States of America

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PREFACE

This report is the final product of an 18-month study by the Committee on Public Understanding of Engineering Messages, a group of experts on diverse subjects brought together under the auspices of the National Academy of Engineering (NAE). The committee's charge was to identify and test a small number of messages that appear likely to improve the public understanding of engineering. To fulfill that charge, the committee used the services of professional marketing and communications firms, hired through a competitive request-for-proposals process. Working with the committee, these firms conducted qualitative and quantitative research to collect data and develop messages, themes, and taglines based on that data.

This report follows *Raising Public Awareness of Engineering*, an NAE report published in 2002, which revealed that the engineering community has been spending hundreds of millions of dollars annually to promote the public understanding of engineering with little measurable impact on young people or adults. That study's committee concluded that the messages being communicated had not been developed in a systematic way and recommended that more effective, consistent messages be developed and used in a coordinated way by

organizations interested in enhancing public understanding of the critical role engineers play in today's world.

Given the concerns in the United States about the importance of STEM (science, technology, engineering, mathematics) education to global competitiveness, national security, and quality of life, the current report is especially timely. But messaging is about much more than "priming" the engineering-education pipeline. The vast majority of Americans will never become engineers, but all Americans—young and old—can benefit by having a better understanding of the role engineers play in the creation of technologies. Effective messaging can help raise the level of technological literacy in the general population, a key competency for the 21st century.

This report will be of special interest to engineering professional societies, technology-intensive industries, colleges of engineering, science and technology centers, and other organizations that communicate with policy makers, K–12 teachers and students, and the public at large about engineering. Federal and state agencies concerned with reforming STEM education and supporting research, innovation, and technology development similarly will find that this report can be useful in outreach efforts.

On behalf of the committee, I urge the engineering community to embrace the very useful information in this document.

Don P. Giddens, *chair*
Committee on Public Understanding
of Engineering Messages

ACKNOWLEDGMENTS

This report has been reviewed, in draft form, by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Academies. The purpose of this independent review process is to provide candid and critical comments to assist the committee and the National Academy of Engineering (NAE) in making its published reports as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The reviewers' comments and the draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their reviews of this report:

Todd R. Allen, Global University Recruitment Team, Johnson & Johnson
Tony Beard, PriceWeber Marketing Communications, Inc.
Leslie Collins, National Engineers Week Foundation
Eugene M. DeLoatch, School of Engineering, Morgan State University

Kimberly D. Douglas, Women in Engineering and Science Program, Kansas State University
Ioannis Miaoulis, Boston Museum of Science
Jon Miller, Department of Political Science, Michigan State University
Teri Reed-Rhoads, College of Engineering, Purdue University
Betty Shanahan, Society of Women Engineers
Lilian Wu, University Relations, IBM

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations and did not see the final draft of the report before its public release. The review was overseen by Robert F. Sproull, Sun Microsystems, Inc., who was appointed by NAE to ensure that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and NAE.

In addition to the reviewers, the committee wishes to thank consultant Maria Ivancin, Market Research Bureau, who assisted the NAE staff in overseeing the research and provided advice throughout the project. Her input was critical to the success of the study.

The committee also thanks the project staff. Maribeth Keitz managed the committee's logistical and administrative needs, making sure meetings ran efficiently and smoothly. NAE senior editor Carol R. Arenberg substantially improved the readability of the report. Study director Greg Pearson managed the project from start to finish.

CONTENTS

*Appendix G is reproduced on the CD (inside back cover) that contains the full report but is not included in the printed report.

CHANGING THE CONVERSATION

EXECUTIVE SUMMARY

Every year, hundreds of millions of dollars are spent in the United States to improve the public understanding of engineering (NAE, 2002). Despite these efforts, educational research shows that K–12 teachers and students generally have a poor understanding of what engineers do (Cunningham et al., 2005; Cunningham and Knight, 2004). Polling data show that the public believes engineers are not as engaged with societal and community concerns as scientists or as likely to play a role in saving lives (Harris Interactive, 2004). And when asked to judge the relative prestige of professions, people tend to place engineering in the middle of the pack, well below medicine, nursing, science, and teaching (Harris Interactive, 2006). Parents, however, are generally amenable to the idea of their sons and daughters opting for careers in engineering.

Understandably, engineers, engineering educators, and the organizations that represent them want people to have an accurate, more positive impression of engineering. However, there also other important reasons for improving the public understanding of engineering:

- **Sustaining the U.S. capacity for technological innovation**. A better understanding of engineering would educate policy makers and the public as to how engineering contributes to economic development, quality of life, national security, and health.
- **Attracting young people to careers in engineering**. A better understanding of engineering should encourage students to take higher level math and science courses in middle school, thus enabling them to pursue engineering education in the future. This is especially important for girls and underrepresented minorities, who have not historically been attracted to technical careers in large numbers.
- **Improving technological literacy**. To be capable, confident participants in our technology-dependent society, citizens must know something about how engineering and science, among other factors, lead to new technologies (NAE and NRC, 2002).

GOAL OF THE MESSAGING PROJECT

The goal of this project, primarily funded by the National Science Foundation with additional support from the Georgia Institute of Technology and the S.D. Bechtel, Jr. Foundation, is to encourage coordinated, consistent, effective communication by the engineering community to a variety of audiences, including school children, their parents, teachers, and counselors, about the role, importance, and career potential of engineering. The project had three objectives:

- to identify a small number of messages likely to improve the public understanding of engineering
- to test the effectiveness of these messages in a variety of target audiences
- to disseminate the results of the message testing to the engineering community

This project did not have the goal of developing metrics for measuring the effectiveness of messaging efforts. Nevertheless, it is reason-

able to ask what one might look for as evidence of "improvement" in public understanding of engineering. One indicator of improvement would be the number and diversity of organizations using this report to shape their engineering outreach. Over time, we would hope to see growth in this set of organizations, and that might be measured through surveys of the engineering community. A longitudinal study, combined with "dipstick" surveys before, during, and after the deployment of new messages, could indicate the extent to which the public recognizes the new messages or associates certain key words, such as creativity and innovation, with engineering.

The remainder of the Executive Summary is focused on survey results for the messages, and it briefly discusses testing data related to several shorter, more punchy "taglines." Additional findings are described in the full report, and complete data tables of the survey results are provided in an accompanying CD. The CD also contains a copy of the full report as a PDF.

METHODOLOGY

Through a request-for-proposals process, the committee selected the communications firm Bemporad Baranowski Marketing Group to oversee message development, in partnership with Global Strategy Group (GSG), a market research company. GSG and Harris Interactive, another market-research firm, were selected to test the messages.

The study used qualitative and quantitative research. The qualitative research included in-depth interviews, youth "triads" (same-sex groups of three 9–11-year-olds), and adult and teen focus groups to determine perceptions of engineers and engineering by different groups as a basis for developing a positioning statement, messages, and taglines. The quantitative research consisted of an online survey that oversampled for African Americans and Hispanics. The goal of the quantitative research was to shed light on the findings of the focus groups and provide a statistically sound foundation for the committee's recommendations. The committee also solicited feedback through presentations at relevant meetings and by posting an interim status report on the National Academy of Engineering (NAE) website to encourage input from a cross section of the engineering community and others.

In the interviews, focus groups, and youth triads, small samples were selected without statistical procedures. The results of this qualitative research had to be tested through quantitative methods. In the quantitative research, the online survey, respondents were part of volunteer survey panels. Thus we could not control exactly who would take part in the survey, and the responses may not accurately reflect the demographics of the sample populations. This common limitation was addressed by weighting (i.e., adjusting survey responses upward or downward to match the demographic variable of interest). Nonresponses also affect the representativeness of a sample, and thus the "generalizability" of the results. Another limitation was that respondents were required to have access to the Internet. In the committee's view, these methodological issues do not detract from the usefulness of the study's findings.

THE ENGINEERING MESSAGING LANDSCAPE

Current and past engineering outreach to the public and message development have been ad hoc efforts, and metrics for tracking results have rarely been used. Although a variety of useful tactics have been tried, no consistent message has been communicated, even among projects by the same organization. Most outreach initiatives target high school students with an eye toward "priming the engineering education pipeline." Less attention has been paid to elementary and middle school students, where efforts would serve a "mainline" function of promoting technological literacy and stimulating interest in mathematics and science. With the notable exception of National Engineers Week, most outreach programs have been local.

In general, messages targeting younger children attempt to convince them that mathematics and science are easy or fun and that engineering is challenging, exciting, hands-on, and rewarding. Messages for older, prospective college students tend to emphasize career potential. For the most part, these have been direct statements emphasizing the personal benefits of being an engineer.

A recurring theme in many messaging efforts is that engineering requires skills in mathematics and science. Frequently, these messages

suggest that students must have an aptitude for and strong interest in these subjects to succeed in engineering.

CHANGING THE CONVERSATION

In collaboration with the committee, the consultants developed a positioning statement to guide future outreach activities by the engineering community (Box ES-1). This optimistic, inspirational statement emphasizes connections between engineering and ideas and possibilities, rather than engineering as a math and science based method of solving problems. The statement describes engineering as inherently creative and concerned with human welfare, as well as an emotionally satisfying calling. In short, the statement changes the tone and content of the conversation about engineering. A positioning statement is the conceptual foundation for a communications campaign, but it is not usually shared with the public.

BOX ES-1
New Positioning Statement

No profession unleashes the spirit of innovation like engineering. From research to real-world applications, engineers constantly discover how to improve our lives by creating bold new solutions that connect science to life in unexpected, forward-thinking ways. Few professions turn so many ideas into so many realities. Few have such a direct and positive effect on people's everyday lives. We are counting on engineers and their imaginations to help us meet the needs of the 21st century.

Findings from the Qualitative Research

Students in the focus groups and triads were asked to describe their images of engineers, their understanding of engineering, their reactions to examples of engineering, their views on current school subjects, and their hopes for future careers. Participants in the parent

group were asked to describe their thoughts and ideas about career choices for their children. Both students and parents were also asked their reactions to several preliminary messaging "themes" (Box ES-2) based on the positioning statement.

BOX ES-2
Preliminary Messaging Themes

Ideas in Action.
This theme underscores how engineering uniquely bridges the world of science with the real world.

Life Takes Engineering.
This theme focuses on the field's essential role and life-changing work.

A Limitless Imagination.
This theme speaks to the innovative, design-driven nature of engineering.

Free to Explore.
This theme evokes the constant journey that is the engineer's quest for new solutions.

Shape the Future.
This theme speaks to how engineering offers an empowering and rewarding career.

An Enterprising Spirit.
This theme recognizes the inventive spirit and pioneering contributions of the field.

Summary Findings: Students

- Most students understand that engineers "design and build things" but have a limited sense of what engineers actually do.
- Students have a generally positive impression of engineers, but many feel that they are not smart enough to become engineers.

- Many students believe engineering work is sedentary, performed mostly on computers, and involves little contact with other people.
- Most girls believe women can be engineers as well as men.
- When asked to name engineers, most students could only name men.
- Examples of engineering related to familiar objects and activities stimulated the most interest in learning more about engineering.
- "Making good money" was named most often as a career goal.[1] However, the idea of "making a difference" also had very strong appeal.

Summary Findings: Parents

- Most parents thought engineering would provide job security (e.g., good salary and benefits) and a career path for advancement and success.
- Parents tended to favor the practical messaging themes, reflecting their emphasis on job security for their children.

Findings from the Quantitative Research

To test the results of qualitative research, the committee collected quantitative data from an online survey administered to nearly 3,600 individuals. The survey instrument comprised six questions about views of engineering and engineers and four questions about the proposed messages and taglines that had been refined to reflect the results of the focus groups and triads (Box ES-3). The survey was administered in two phases: to an initial sample of teens and adults in December 2006 and an oversample of African American and Hispanic teens and adults in spring 2007.

All five messages were scored at least "somewhat appealing" by the overwhelming majority of adults and teens. The message with the

[1]By contrast, teens in the online survey rated the importance of salary second or third behind "interesting work" and "work that makes a difference, is meaningful."

BOX ES-3
Messages Tested in the Online Survey

Engineers make a world of difference.*
From new farming equipment and safer drinking water to electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways.

Engineers are creative problem-solvers.
They have a vision for how something should work and are dedicated to making it better, faster, or more efficient.

Engineers help shape the future.
They use the latest science, tools, and technology to bring ideas to life.

Engineering is essential to our health, happiness, and safety.
From the grandest skyscrapers to microscopic medical devices, it is impossible to imagine life without engineering.

Engineers connect science to the real world.
They collaborate with scientists and other specialists (such as animators, architects, or chemists) to turn bold new ideas into reality.

*This message was inspired by a similar theme used to promote National Engineers Week.

highest "very appealing" rating among all groups was "Engineers make a world of difference." This message was also considered the "most believable" and "most relevant." In general, however, girls were less enthusiastic than boys about all of the messages.

"Engineers connect science to the real world" was given the fewest votes for "very appealing" among all groups and was the least "personally relevant" for all groups but African American adults. This finding was confirmed when survey participants were asked to choose a single "most appealing" message.

The survey also revealed some significant gender differences. For example, boys in the initial sample found "Engineering makes a world of difference" and "Engineers are creative problem solvers" equally appealing. Girls also found "Engineering makes a world of difference" the most appealing. However, the second most appealing message for girls was "Engineering is essential to our health, happiness, and safety." Girls ages 16 to 17 in the African American sample and all girls in the Hispanic sample found this second message significantly more appealing than did the boys in those groups.

Testing of Preliminary Taglines

In addition to messages, the online survey tested several preliminary taglines (Box ES-4). Because of time and funding constraints, the taglines had been developed intuitively from the results of the qualitative research, without the benefit of creative prototypes (such as posters, TV ads, or web pages). In addition, the taglines were only tested in the online surveys. Thus the results may not represent the best measure of their true potential. Nevertheless, several taglines tested well.

The tagline "Turning ideas into reality" tested well among all survey respondents. This straightforward tagline, which is consistent with the messages used to promote National Engineers Week, is more descriptive than evocative and conveys a direct message that does not require additional creative context. As a stand-alone *tagline*, it makes

BOX ES-4
Preliminary Taglines

- Turning ideas into reality
- Because dreams need doing
- Designed to work wonders
- Life takes engineering
- The power to do
- Bolder by design
- Behind the next big thing

the most sense of the seven. It is interesting to note, however, that the phrase "ideas into reality" also appears in the full description of "Engineers connect science to the real world," which was the least appealing of the five tested messages, especially among women. This discrepancy reinforces the need for additional testing of taglines. A tagline that tested especially well among teens in the initial survey was "Because dreams need doing."

CONCLUSIONS AND RECOMMENDATIONS

Happily, our research showed that engineers do not have major image problems. In fact, contrary to the image engineers have of themselves, the public views engineering and engineers in a relatively positive light. Our research showed that fewer than 15 percent associated the words "boring" or "nerdy" with engineering. In fact, most adults and teens respect engineers and consider their work rewarding and important, but perhaps not enough to inspire them to become engineers.

We did find that the public has a poor idea of what engineers actually do on a day-to-day basis; and there is a strong sense that engineering is not "for everyone," and perhaps especially not for girls. Most current messages are framed to emphasize the strong links between engineering and just one of its attributes—the need for mathematics and science skills. In other words, current messages often ignore other vital characteristics of engineering, such as creativity, teamwork, and communication.

Based on our research, we can make a strong case that effective messaging will require audience segmentation. The "branding" of engineering must be modified to appeal to (1) teens in general, (2) teenage boys, and (3) teenage girls, as well as to (4) adults.

RECOMMENDATIONS

The committee's first two recommendations address how the positioning statement and messages should be used. These recommendations are immediately actionable by organizations interested in improving public understanding of engineering. The third and fourth

recommendations, which suggest the need to refine the preliminary taglines and to develop a public relations "tool kit" for the engineering community, can be addressed in the near term and will require dedicated personnel and funding. Efforts to carry out the last recommendation, which proposes an ambitious, large-scale communications "campaign," can begin immediately, but successful implementation will require long-term, sustained effort by many organizations.

Using the Positioning Statement

Recommendation 1. To present an effective case for the importance of engineering and the value of an engineering education, the engineering community should engage in coordinated, consistent, effective communication to "reposition" engineering. Specifically, the engineering community should adopt and actively promote the positioning statement (Box 4-1) in this report, which emphasizes that engineering and engineers can make a difference in the world, rather than describing engineering in terms of required skills and personal benefits. The statement should not appear verbatim in external communications but should be used as a point of reference, or anchor, for all public outreach.

One of the most significant findings of this project is the strong association in the mind of the public between competency in mathematics and science and the ability to become an engineer. "Must be good at math and science" was by far the most frequently selected attribute of engineering in the online survey, suggesting that messages emphasizing this attribute have been understood by all adults and teenagers. Unfortunately, many of them appear to consider this a negative, a barrier to engineering studies. In keeping with this finding, our testing also showed that the weakest of the five tested messages portrayed engineers as "connecting science to the real world."

We conclude, therefore, that continuing to emphasize math and science in marketing or rebranding engineering is unnecessary and may damage rather than increase the appeal of engineering. The same can be said of messages that focus on the practical benefits of

being an engineer, rather than the inspirational, optimistic aspects of engineering.

An example of how the medical profession is promoted may help illustrate the potential value of Recommendation 1. The medical profession does not market itself to young people by pointing out that they will have to study organic chemistry or by emphasizing the long, hard road to becoming a physician. The image of the physician is of a person who cures diseases and relieves human suffering.

When promoting engineering, our appeal should tap into the hopes and dreams of prospective students and the public. This approach would also have the virtue of placing math and science, correctly, as just two of a number of skills and dispositions, such as collaboration, communication, and teamwork, necessary to a successful engineer.

Adopting Tested Messages

Recommendation 2. The four messages that tested well in this project—"Engineers make a world of difference," "Engineers are creative problem solvers," "Engineers help shape the future," and "Engineering is essential to our health, happiness, and safety"—should be adopted by the engineering community in ongoing and new public outreach initiatives. The choice of a specific message should be based on the demographics of the target audience(s) and informed by the qualitative and quantitative data collected during this project.

Our research should not preclude others from pursuing message development, but we strongly feel that the rigorous process we used to generate our messages justifies their widespread use. In February 2008, the NAE launched a new website, Engineer Your Life (*www.engineeryourlife.org*), which aims to interest academically prepared high school girls in careers in engineering. The site used our message "Engineers make a world of difference" on its homepage and adopted other key words vetted in our research, such as creativity and problem-solving.

Using the Preliminary Taglines

Recommendation 3. More rigorous research should go forward to identify and test a small number of taglines for a nationwide engineering-awareness campaign. The taglines should be consistent with the positioning statement and messages developed through this project and should take into account differences among target populations. In the interest of encouraging coordination among outreach activities, the results of this research should be made widely available to the engineering community.

Given additional resources, it would have been useful in this project to develop and test more taglines in context and to test the contextualized taglines in focus groups. The results reported here should be viewed as preliminary, but the positive responses to several of our preliminary taglines in online testing suggest that they may be able to be used effectively for engineering-outreach projects.

Developing a Shared Public-Relations Resource

Recommendation 4. To facilitate the deployment of effective messages, an online public relations "tool kit" should be developed for the engineering community that includes information about research-based message-development initiatives and examples of how messages have and can be used effectively (e.g., in advertising, press releases, informational brochures, and materials for establishing institutional identity). The online site should also provide a forum for the sharing of information among organizations.

One reason ad hoc efforts to promote public awareness of engineering have had limited success, at best, is that they do not convey consistent messages. In addition, because of the discontinuity and lack of coordination among these activities, effective metrics cannot be used to refine messages or improve outreach. The committee believes that, in the short term, consistent use of messages, even by a modest number of organizations, would be a huge step forward in promoting a more positive public perception of engineering.

Launching a Campaign

Recommendation 5. A representative cross section of the engineering community should convene to consider funding, logistics, and other aspects of a coordinated, multiyear communications campaign to improve the public understanding of engineering.

Over the long term, the committee believes a more explicit, coordinated approach to public outreach is likely to yield better results than we have obtained so far. Thoughtful targeting of the messages and further refinement of taglines will be necessary, but not sufficient, for success. Messages and taglines must be embedded in a larger strategic framework—a communications campaign. The most effective campaigns are driven by a strong brand position communicated in a variety of ways, delivered by a variety of messengers, and supported by dedicated resources. Effective campaigns also measure the impact of their activities and, most important, are given enough time to succeed.

A campaign of the necessary size and duration to measurably improve the public understanding of engineering will require significant resources. Our consultants proposed a "conservative" price tag of $12 million to $25 million per year for two or three years. The committee believes that, although this may be enough to initiate a campaign, the long-term costs would be much higher.

Three concerns must be addressed for such an undertaking. First, resources on this scale are not likely to be provided by government or foundations. The engineering community, particularly large, influential, technology-focused corporations, must be enlisted to support the campaign.

Second, the committee believes that centralized planning will be necessary to ensure effective coordination and communication, which would require agreement by the major participants. National Engineers Week, a cooperative outreach venture in engineering, might be leveraged for this purpose. However, the creation of a new structure may be necessary to coordinate a campaign.

Third, metrics will be essential to determining the effectiveness of messages, strategies, and taglines. Although measuring the outcomes of public outreach efforts is notoriously difficult, a campaign of this

scope must include a substantial evaluation component to determine what works and to improve upon elements that are not as effective as expected.

A FINAL WORD

The project described in this summary and expanded upon in the full report has followed a carefully designed process for developing messages for public understanding of engineering. The approach utilized the services of professionals in the fields of communications and market research, and it employed quantitative as well as qualitative research methods. To ensure balance and accuracy, the committee's report and its findings and recommendations were carefully reviewed by an outside group of experts. The rigor of the study process should reassure the engineering community—and others interested in this important topic—that there is now a tested set of tools available to promote a more positive image of the field.

The most significant outcome of this project is the recasting of engineering in the positioning statement. If it is adopted by the engineering community, it will not only reshape engineers' self-image, but will also empower engineers to communicate more confidently with the public.

As work continues on enriching, expanding, and disseminating messaging resources, the engineering community can take immediate action. Even if a national campaign is not immediately forthcoming, the creative implementation of the messages and taglines in this report can have an impact. Combined, consistent efforts by multiple organizations following the same "playbook" can create positive momentum toward making engineering more appealing and better understood by students, educators, parents, policy makers, and society at large. In this way, we may truly begin to change the conversation.

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INTRODUCTION

Considerable efforts have been undertaken in the United States to improve the public understanding of engineering (PUE). A survey by the National Academy of Engineering (NAE) in 2002 of 177 organizations involved in public understanding of engineering activities revealed that they spend an estimated $400 million annually (NAE, 2002). However, the actual national investment can be assumed to be much higher, because the survey is believed to have reached only a fraction of the institutions that have PUE initiatives.

Despite these efforts, the impact of engineering on our daily lives, the nature of what engineers do, and the opportunities available through an engineering education are still largely unknown to most Americans. Educational researchers have found that K–12 teachers and students generally have a poor understanding of what engineers do (Cunningham and Knight, 2004; Cunningham et al., 2005, 2006). Polling data comparing scientists and engineers show that the public sees engineers as being more responsible for creating economic growth and preserving national security than scientists, as well as more likely to make strong leaders. However, engineers are not perceived to be as engaged with societal and community concerns or to play as great a role

in saving lives (Table 1-1). And when the relative prestige of all professions is tallied, engineering falls in the middle of the pack, well below medicine, nursing, science, and teaching (Table 1-2).

Although engineers, engineering educators, and the organizations that represent them want people to have more accurate and positive impressions of them, there are other, more important reasons for improving the public understanding of engineering. Some knowledge about how engineering work is done, for example, is fundamental to technological literacy. To be fully capable and confident in a technology-dependent society, every citizen should understand something of the process of engineering and how engineering and science, among

TABLE 1-1 Comparative Characteristics Associated with Engineers and Scientists, 2003 and 1998

	Engineers	Scientists	Neither	Don't Know	Decline to Answer
Creates economic growth					
2003	69%	25%	2%	3%	*
1998	51%	25%	—	5%	1%
Preserves national security					
2003	59%	29%	5%	6%	1%
1998	36%	22%	—	9%	2%
Would make a strong leader					
2003	56%	32%	6%	5%	*
1998	47%	28%	—	8%	3%
Saves lives					
2003	14%	82%	1%	2%	*
1998	6%	65%	—	3%	21%
Is sensitive to societal concerns					
2003	28%	61%	5%	5%	*
1998	47%	57%	—	8%	3%
Cares about the community					
2003	37%	51%	5%	6%	1%
1998	24%	46%	—	9%	12%

NOTE: Numbers from 1998 do not add up to 100 because respondents chose from three answers: engineers, scientists, and technicians. Some numbers from 2003 do not add to 100 due to rounding.

*Less than 1 percent.

SOURCE: Adapted from Harris Interactive, 2004.

TABLE 1-2 Percent of Americans Who Rate Selected Professions as Having "Very Great Prestige," 2006

Profession	Percent	Profession	Percent
Firefighter	63%	Architect	27%
Doctor	58%	Athlete	23%
Nurse	55%	Lawyer	21%
Scientist	54%	Entertainer	18%
Teacher	52%	Accountant	17%
Military officer	51%	Banker	17%
Police officer	43%	Journalist	16%
Priest	40%	Union leader	12%
Farmer	36%	Actor	10%
Engineer	34%	Stock broker	11%
Member of Congress	28%	Real estate agent	6%

SOURCE: Adapted from Harris Interactive, 2006.

other factors, lead to the development of technologies (NAE and NRC, 2002; AAAS, 1990).

A number of important public policy issues, from global warming to the marketing of genetically modified foods, involve scientific and technical issues. Decision making on these and other topics will involve trade-offs, as we attempt to simultaneously manage limited resources while sustaining quality of life. Public discourse and the democratic process could be enhanced if citizens understood more about how engineers are trained and what the practice of engineering entails. Technological literacy also is important to consumer decision making. Americans are often the first adopters of new technologies, and part of that acceptance depends on understanding the engineering process. Thus improved public understanding of engineering could enhance consumer decision making.

Improved public understanding of engineering may also support U.S. efforts to maintain our capacity for technological innovation, an issue that has received considerable attention recently (Council on Competitiveness, 2004; NAS et al., 2007; PCAST, 2004). Although there are many aspects of this challenge, two important conditions for sustaining U.S. innovative capacity are improving undergraduate engineering education (NAE, 2005a) and increasing investment in basic

engineering research (NAE, 2005b). Effective action in both areas will depend partly on how well policy makers and the public understand what engineering is and how it contributes to economic development, quality of life, national security, and health—information that could be conveyed through effective messaging.

A related concern is the rapid increase in scientists and engineers in other nations, particularly China and India. For example, the number of graduates with four-year degrees in engineering, computer science (CS), and information technology (IT) in China more than doubled from 2000 to 2004 (Wadhwa et al., 2007). However, because of differences in methods of data collection and in defining engineering, it is difficult to compare the absolute numbers of four-year engineering degrees awarded in China and India to those awarded in the United States. In the 2003–2004 academic year, for bachelor's degrees in engineering, CS, and IT combined, Wadhwa et al. (2007) estimate that the United States graduated 137, 437, India 139,000, and China 361,270.

The overall number of engineering degrees granted in the United States, which had been dropping, has gone up in recent years, although not to its historic high in 1985 (Figure 1-1). According to one estimate,

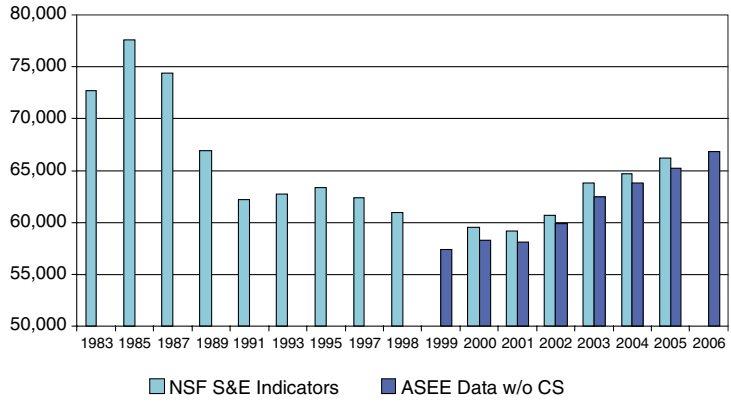

FIGURE 1-1 Engineering bachelor's degrees awarded in the United States, 1983–2006.
NOTE: Bachelor's degrees in computer science (CS) have been subtracted from the original ASEE data (Gibbons) to ensure comparability with NSF data.
SOURCES: Gibbons, 2006; NSF, 2006a.

the U.S. engineering workforce is expected to increase by 13 percent from 2004 to 2014 (CPST, 2006). However, the accuracy of this projection will be affected by several factors, such as participation levels of foreign-born individuals in the U.S. engineering enterprise, the off-shoring of U.S. engineering jobs (NAE, 2008), and engineer retirements in such sectors as defense and aerospace. Thus it is very difficult to predict the long-term demand or supply of engineers in the United States.

Although researchers and policy makers disagree on the nature and extent of the engineering "shortage" in the United States, few dispute the need to attract capable students, especially girls and certain minorities, into technical careers. Women, African Americans, Hispanics, Native Americans, and some Asian American groups are significantly underrepresented in engineering, based on their proportions in the population at large (Box 1-1). If current demographic trends continue, by 2050 almost half the U.S. population will be non-white (U.S. Census Bureau, 2002). In the future, engineering solutions will have to be acceptable to this increasingly diverse population, and the engineering profession will have to draw more heavily on underrepresented groups for the country to maintain, let alone increase, its technological capability (NAE, 2004). Thus messages that effectively encourage girls and underrepresented minorities to consider careers in engineering could be crucial to U.S. success and leadership in the future.

MESSAGES TO PROMOTE THE PUBLIC UNDERSTANDING OF ENGINEERING

In the NAE report *Raising Public Awareness of Engineering* (2002), "message," in the context of public relations, was defined as "a statement that helps convey a positive image, usually either of a company or a specific product." In well-designed communications strategies, messages are repeated over time, because public perceptions are influenced most by repeated exposure to consistently expressed ideas. Although neither engineering nor the public understanding of engineering is a corporate entity or—strictly speaking—a product, messaging is nevertheless germane in this context. Indeed, effective messaging is a

BOX 1-1
Selected Data for Women, African Americans, Hispanics, and Native Americans in Engineering

Women

Proportion of U.S. population, 2005 (est.):	**50.7 percent**
Proportion enrolled in degree-granting institutions, 2004:	**57.4 percent**
Proportion of bachelor's degrees in engineering, 2004:	**20.5 percent**
Proportion of tenured/tenure-track appointments on U.S. engineering faculties, 2005:	**10.6 percent**
Proportion employed as engineers, 2003:	**11.0 percent**

African Americans

Proportion of U.S. population, 2004:	**12.8 percent**
Proportion enrolled in degree-granting institutions, 2004:	**12.5 percent**
Proportion of bachelor's degrees in engineering earned, 2004	**5.3 percent**
Proportion of tenured/tenure-track appointments on U.S. engineering faculties, 2005:	**2.3 percent**
Proportion employed as engineers, 2003:	**3.1 percent**

Hispanics

Proportion of U.S. population, 2004:	**14.1 percent**
Proportion enrolled in degree-granting institutions, 2004:	**10.5 percent**
Proportion of bachelor's degrees in engineering, 2004:	**7.4 percent**
Proportion of tenured/tenure-track professors on U.S. engineering faculties, 2005:	**3.2 percent**
Proportion employed as engineers, 2003:	**4.9 percent**

Native Americans

Proportion of U.S. population, 2004:	**1.0 percent**
Proportion enrolled in degree-granting institutions, 2004:	**1.0 percent**
Proportion of bachelor's degrees in engineering, 2004:	**0.6 percent**
Proportion of tenured/tenure-track professors on U.S. engineering faculties, 2005:	**0.2 percent**
Proportion employed as engineers, 2003:	**0.3 percent**

SOURCES: NSF, 2005a, b, 2006a, b; U.S. Census Bureau, 2002, 2005; DOEd, 2006a, b.

necessary—although not a sufficient—method of promoting public understanding of engineering efforts.

The 2002 NAE report catalogs a large number of messages on a variety of themes that organizations involved in public understanding of engineering have used to promote their activities. The four major themes are: the value and nature of engineering and engineers; the academic skills necessary to pursue engineering as a career; employment opportunities in engineering; and the connection between engineering and quality of life.

The number and variety of messages leads to several conclusions. First, no apparent effort has been made in the engineering community to develop consistent messages. Second, few organizations involved in promoting public understanding of engineering have developed their messages in a systematic, scientific way or tested the effectiveness of their messages. Third, no convincing evidence shows that messaging efforts to date have significantly improved public understanding of engineering.

We know that a public image is not "everything," as the advertisement for Nikon cameras asserted more than a decade ago, but neither is it inconsequential. In the case of engineering, data collected for this project show that the public view of engineering is not strongly negative. At the same time, the data suggest that public perceptions of engineering are based on a limited idea of what it takes to *do* engineering (e.g., skill in mathematics and science) rather than what it means to *be* an engineer (e.g., to work creatively in teams to develop technologies that improve people's lives).

PRIMER ON MARKET RESEARCH: LEXICON AND METHODS

A professional marketing firm was hired to ensure that the committee took a professional approach to improving public understanding of engineering. In addition, committee members were obliged to learn marketing terminology. Learning the vocabulary for any subject requires not only memorizing terms, but also acquiring an understanding of the underlying concepts and methodology. In this section, we outline the essential terms and marketing concepts the committee used in preparing this report and recommendations.

Definition of a Brand

In this project, we were looking for the best way to brand engineering. Although the word *brand* seems familiar, it is used in a specific way in this report. By brand we mean an association of specific traits in a person's mind that induces behavior. A simple way of understanding this concept might be as a warranty—a promise to perform or deliver. For example, the McDonald's brand promises clean restaurants and food of a known quality. We use this brand as a shortcut in decision making. For example, when traveling on the road, we rely on McDonald's promise to provide a quick, adequate meal. The same thing happens with brands in a grocery or hardware store. As we shop, we make quick judgments based on a brand's promise or warranty.

Contemporary marketing practice and theory support branding that goes beyond traditional ideas of a product. For example, entire industries have attempted to remake their public image using branding techniques. The dairy industry's "Got Milk" campaign (*www.bodybymilk.com*) uses well-known sports and entertainment figures to cultivate a wholesome brand image for milk drinkers. Similarly, the cotton industry's "Fabric of Our Lives" campaign (*www.thefabricofourlives.com*) ties a broad range of cotton-based products to aspects of daily life. Marketing has been used by public health officials to brand desirable behaviors, such as healthy eating in adults (i.e., the Food and Drug Administration's "Calories Count" campaign; FDA, 2004) and exercise in children (i.e., the Centers for Disease Control and Prevention's "Verb, It's What You Do" campaign; *www.verbnow.com*).

Some professions have a clear brand identity. Physicians, for examples, are "healers." Teachers are "educators." For professions that do not have a clear brand identity, the public may provide one. Lobbyists and others operating in the political sector can be known as "influence peddlers." And for those in public relations, derisive terms like "flack" and "spin doctor" are common. In the case of engineering, although negative terms like "nerd" and "boring" are part of the brand image, our research and research by others indicate the larger problem is a lack of understanding of what engineers do rather than a negative impression of the field. The actuarial field has a similar concern and has undertaken branding efforts to better communicate to the public how

actuaries add value (Beuerlein, 2006). Nurses in the United Kingdom, concerned about their relatively low status and poor image, recently launched a "Nursing the Future" campaign (*www.nursingthefuture.org.uk/index.php*). To attract students and counter the stuffy image of accountants, the American Institute of Certified Public Accountants developed the "Start Here Go Places" campaign (*www.startheregoplaces.com*).

In this study, we considered the following brand attributes: brand message, the promise the brand communicates; brand image, how the brand is marketed; and brand experience, how the message is brought to life and made concrete.

The Positioning Statement

A *positioning statement* is essential for creating a brand. It lays out how one wants the brand to be perceived and provides the core message to be delivered in every medium. A typical positioning statement answers seven core questions about a brand:

1. Who are you?
2. What business are you in?
3. What people do you serve?
4. What are the special needs of the people you serve?
5. Who are your competitors?
6. What makes you different from your competitors?
7. What unique benefit does a user derive from your service or product?

To illustrate how a position statement works, consider a high-end store like Bloomingdale's. The position statement (Beckwith, 1997) reads:

> Bloomingdale's (*who*) is a fashion-focused department store (*what business)* for trend-conscious, upper-middle-class shoppers (*who served*) looking for high-end products (*special needs*). Unlike other department stores (*competitors*), Bloomingdale's provides unique merchandise in a theatrical setting (*the difference*), which makes shopping entertaining (*unique benefit*).

Note that this statement never appears explicitly in Bloomingdale's ads or marketing. The purpose of a positioning statement is to guide decisions about how to deliver a brand message. A marketing firm uses the statement to create the elements of a campaign. For example, Bloomingdale's highlights items in its ads and creates displays in its stores that reinforce the idea of "shopping entertainment."

A positioning statement, of course, applies not only to traditional stores like Bloomingdale's, but can also be a powerful tool, for example, in a high-tech industry. In 1991, Intel Corporation launched a brand campaign for its computer processors. At the time, few consumers had any idea what a microprocessor was, let alone a strong brand identification or preference for a particular type of processor. Most consumers cared as much about who made their processors as they did about who built the engines in their cars.

This presented a dilemma for Intel, which wanted to reap the benefits of its advances in chip design. So, the firm decided to brand its processors, thus linking Intel and its innovations. This was a revolutionary idea, because at the time, consumers knew next to nothing about microprocessors. A measure of the campaign's success is that today people discuss the speed of their processors, and even mention their name.

We can imagine Intel using something like the following positioning statement, which we crafted based on the history of the Intel Inside® Program (Intel Corporation, 2008), to create its brand:

> Intel (*who*) produces microprocessors (*what business*) for end users of personal computers (*who served*) looking for the best technology (*special need*) linking words like "leading technology" and "reliability" (*unique benefit*) with Intel microprocessors rather than other producers of microprocessors (*competitors*).

Messages and Taglines

The key elements of messaging campaigns, like Bloomingdale's and Intel's, are *messages* and *taglines*, which are easily confused. The message, the longer and more detailed of the two, is often a complete sentence that clearly articulates a brand promise. For example, the message of Anadin™, a pain killer, makes an explicit promise in, "Nothing

acts faster than Anadin™." In contrast, a tagline is a short phrase, rarely a complete sentence, that creates an image in the consumer's mind. One committee member described taglines as "concretely vague," somewhat like a Madison Avenue haiku that resonates emotionally with consumers.

Intel's now-ubiquitous tagline is "Intel Inside," which cleverly draws attention to a tiny, rarely seen, but essential component of the computer "brain." Ford Motor Company's tagline for its Lincoln Town Car is "Signature of Success," which taps into the self-image of consumers who might purchase these luxury cars.

Two examples from this project can help clarify the differences between messages and taglines. As noted above, we engaged a marketing firm to develop and test engineering messages and taglines. One message we tested was:

> Engineers make a world of difference. From new farming equipment and safer drinking water to electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways.

One of several taglines we tested reads:

> Because dreams need doing

To develop and test messages and taglines, the marketing company conducted research in the form of focus groups and surveys.

The Role of Research

Marketing research suggests reasonable actions to take in creating a brand, rather than charting a definitive course to success. Much like social science research, marketing research reveals trends that can simplify a complex whole by breaking it into manageable parts. Research does not tell us which branding elements to use, but it provides insights that inform, rather than replace, decision making. Marketing research serves two main purposes in creating a branding campaign.

First, marketing research reveals how prospective consumers perceive a product or service. One might naively assume that a firm can state a position and then broadcast that position in all of its marketing. In reality, a marketer does not create a position de novo, but links a new position to an old position that already exists in the consumer's mind.

For example, in the 1960s, Avis wanted to let potential customers know that it offered better service than Hertz, the top rental-car company, but research revealed that consumers did not find this claim credible. In fact, consumers always thought of Avis as second to Hertz. In an ingenious advertising campaign, Avis used the tagline, "We're number two, so we try harder." Because this tagline connected to an idea already in consumers' minds, it instantly resonated with them, and Avis' revenues skyrocketed (*Wall Street Journal*, 1969). This is a clear example of how a marketing firm used research to get a good picture of the messaging landscape and created a tagline that linked a new position to an old one.

The second way marketing firms use research is to test messages and taglines. Testing can reveal the most popular or appealing brand elements, but more important, it can reveal unanticipated problems. For example, a tagline that appeals to a marketer and client may have unintended negative connotations for the target audience.

In our research, we were particularly interested in developing an exhaustive, fine-grained description of the perceptions of different groups about engineering as a profession. This required the systematic collection of data from well-defined sample groups using standardized questionnaires that would provide a basis for making comparisons.

The paramount criteria for evaluating all social science research are *validity* and *reliability*. *Validity* means that our results tap into the underlying behaviors or attitudes we want to measure. Can a survey questionnaire, for example, adequately assess people's complex attitudes toward engineering? *Reliability*, on the other hand, refers to consistency of measurement. Can we administer the same questionnaire consistently to a large number of respondents, for instance, without contaminating our results because of differences in how the interviews were conducted?

All researchers must make trade-offs between reliability and validity. Standardized surveys are very reliable in how they are administered and in how they measure underlying constructs, such as attitudes and behaviors. At the same time, their validity is limited, because they reduce complex attitudes to short questions with answers that are often forced into predefined numerical scales.

The problem is often reversed for focus groups and other qualitative methods, which enable us to explore behaviors and attitudes in great depth and include a good deal of contextual information. Therefore, they produce more valid results than standardized surveys. However, the very fact that they take into account individual differences and complexities diminishes their reliability for comparisons among different groups. The fact that we used a semi-structured interview protocol for the focus groups corrected somewhat for this limitation.

For our project, therefore, we "triangulated" these methods, combining qualitative approaches, such as focus groups, with quantitative data collection using systematic population surveys. This enabled us to leverage the specific advantages of each method in terms of reliability and validity and, at the same time, minimize their weaknesses by comparing results. (The committee discusses other technical issues, including factors that affect generalizability of data, in an annex to this chapter.)

THE NAE MESSAGING PROJECT

This project is based on the hypothesis that concise, effective messaging can help correct misconceptions about, and improve the image of, engineers and engineering. Effective messages will be a compelling and consistent way for the engineering community to promote itself to diverse audiences. NAE recognizes that effective messages are a critical (but not sufficient) element in cultivating greater public awareness. Messaging must be a component in a sustained engineering-community-wide campaign that also includes improving undergraduate engineering education and increasing investment in basic engineering research.

Goal and Objectives of the Project

The stated goal of this project, funded by the National Science Foundation (NSF) and small, supplemental grants from the Georgia Institute of Technology and the S.D. Bechtel, Jr. Foundation, is to encourage coordinated, consistent, effective communication by the engineering community about the role, importance, and career poten-

tial of engineering to a variety of audiences, including school children, parents, teachers, and counselors. The project hopes to achieve three specific objectives:

- Identify a small number of messages that appear likely to lead to a better understanding of engineering.
- Test the effectiveness of these messages in a variety of audiences.
- Disseminate testing results to the engineering community.

This project did not have the goal of developing metrics for measuring the effectiveness of messaging efforts. Nevertheless, it is reasonable to ask what one might look for as evidence of "improvement" in public understanding of engineering. One indicator of improvement would be the number and diversity of organizations using this report to shape their engineering outreach. Over time, we would hope to see growth in this set of organizations, and that might be measured through surveys of the engineering community. The committee believes that effective messaging will equip people with a positive and authentic vocabulary for describing and thinking about engineering. In addition, effective messaging should have an impact on student views about engineering as a career option. One approach for gathering this kind of information would be a longitudinal study, combined with "dipstick" surveys before, during, and after the deployment of new messages. Such a study could determine the extent to which the public recognizes the new messages or associates certain key words, such as creativity, with engineering, and it could probe students for how messages are influencing their views about career and college choice. Less direct evidence of impact might be obtained by tracking changes in responses to periodic national surveys, such as those on professional prestige conducted by Harris Interactive; commissioning new surveys, for example, of high school students views about engineering; or analyzing factors leading to changes in enrollments in engineering schools.

Public Outreach

During the course of this project, the committee solicited feedback in two ways. First, committee members and project staff made presentations about the project at meetings where the topic of public understanding of engineering was likely to resonate. These events included the April 2007 meeting of the NAE Council; the annual Convocation of Professional Engineering Societies and the NAE in May 2007, which brought together the presidents, presidents-elect, and executive directors of major national engineering professional associations to discuss issues of mutual interest; the May 2007 and April 2008 meetings of the advisory committee to the Engineering Directorate of the NSF, which funded the project; the June 2007 annual meeting of the American Society for Engineering Education; and the January 2008 meeting of the Association of Independent Technical Universities. At each event, the goals and research findings of the project generated considerable discussion.

To obtain feedback from a wider cross section of the engineering community and the general population, in March 2007 the committee posted a report by the project consultants, Bemporad Baranowski Marketing Group/Global Strategy Group, on the NAE website that provided background material and summarized the findings of the qualitative research and the survey's initial sample. (Results of the oversamples of African American and Hispanic teens and adults were not available until June, too late to allow for public comment.)

The committee notified a number of groups about the posting, including NAE members; the National Academies Teacher Advisory Council; a number of engineering societies (e.g., American Society of Mechanical Engineers, Institute for Electrical and Electronics Engineers, American Society of Civil Engineers, National Society of Professional Engineers, National Society of Black Engineers, Society of Women Engineers, American Society of Engineering Education); the International Technology Education Association, which represents K–12 technology education teachers; the Association of Science-Technology Centers, which represents many science and technology museums; and the National Association for College Admission Counseling.

From March through June 2007, the committee received comments on the consultants' report from more than 80 organizations and individuals. The great majority of these were from engineers, including 10 NAE members, three deans of schools of engineering, and individual engineers who teach in universities or work in industry. The committee also received comments from a handful of K–12 teachers, mostly teachers of technology, mathematics, and science.

The comments included a number of suggestions for using the messages, arguments in favor of particular messages, and proposals for conducting a large-scale campaign to improve public understanding of engineering. There were also a number of insightful comments on issues not directly considered in this project, such as the lack of opportunities for K–12 students to study engineering and the quality of post-secondary engineering education. Where appropriate, references to these comments are included in the committee's report.

The Report

Chapter 2 describes the committee's efforts to develop a positioning statement and preliminary message themes as guidelines for the research phase of the project. Chapter 3 presents the results of that research. Chapter 4 provides the committee's conclusions and recommendations. Appendix A contains short biographies of committee members, Appendix B is the moderator's guide for the in-depth interviews, Appendix C is the moderator's guide for the parent focus groups, Appendix D is the moderator's guide for the teen focus groups, Appendix E is the moderator's guide for the youth triads, and Appendix F is the online survey. A separate CD contains complete data tables for the online survey and a PDF version of the full report.

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ANNEX
GENERALIZABILITY OF SURVEY DATA

Generalizability, the capability of making inferences from a sample to the target population, is an essential aspect of survey research. The most commonly used inferential statistic is *sampling tolerance*, often called the *margin of error***.** We prefer the former term, because the margin of error suggests, incorrectly, that there is something wrong with the data, whereas sampling tolerance refers to the difference between results from the sample and results anticipated in the target population as a whole.

Sampling tolerance varies by the size of the sample (the larger the sample, the smaller the tolerance) and the reported percentage response to a particular survey question (the closer the response percentage is to 50 percent, the larger the sampling tolerance). Table 1-3 illustrates how these factors affect tolerance for individual data points. Sampling tolerances are often expressed as plus or minus values (+/–), or ranges, around the data point of interest.

TABLE 1-3 Sampling Tolerances for Single Samples

	Reported Percents				
Sample Size	10% or 90%	20% or 80%	30% or 70%	40% or 60%	50%
100	5.9	7.8	9.0	9.6	9.8
200	4.2	5.5	6.4	6.8	6.9
300	3.4	4.5	5.2	5.5	5.7
400	2.9	3.9	4.5	4.8	4.9
500	2.6	3.5	4.0	4.3	4.4
600	2.4	3.2	3.7	3.9	4.0
700	2.2	3.0	3.4	3.6	3.7
800	2.1	2.8	3.2	3.4	3.5
900	2.0	2.6	3.0	3.2	3.3
1000	1.9	2.5	2.8	3.0	3.1
1500	1.6	2.0	2.4	2.5	2.6
2000	1.3	1.8	2.1	2.2	2.2
5000	0.8	1.1	1.3	1.4	1.4

SOURCE: ICR, 2007.

Our surveys had a 95 percent *confidence level*, the industry standard. This means that we can be 95 percent certain that the value for the true population falls somewhere within the margin of error around what we observed in our sample. For example, as Table 1-3 shows, for a sample of 600 people, if 20 percent chose a particular answer choice, the sampling tolerance would be +/– 3.2 percent, and the answer range would be between 17.8 percent and 23.2 percent. This means that we can predict with 95 percent certainty that the percentage of individuals in the population we drew our sample from fall within the calculated range. The same principle applies when two data points are compared, although the calculation is more involved, particularly if the sample sizes vary. In this case, the difference between the numbers is considered *statistically significant* if it exceeds the sampling tolerance.

The correct calculation of inferential statistics depends on each respondent having the same, known chance of being selected into the sample. For example, to survey the opinions of the U.S. population as a whole, the survey sample would include representative numbers of people, in terms of age, gender, race or ethnicity, and geographic location, just to name the most obvious demographic markers. Such sam-

ples are usually referred to as *probability samples*. Because we relied on respondents who were members of volunteer survey panels, we could not control who chose to take part in our survey. Thus our responses do not reflect exactly the demographics of the populations we were sampling, and our samples are technically not probability samples.

This is a common occurrence in surveys that is typically handled by *weighting*, or propensity scoring, a process by which survey responses are adjusted upward or downward to match the actual demographic variable of interest. Weighting is often based on population data from the U.S. Census Bureau. For instance, if there were only 25 women in a sample of 100 people and we were interested in comparing the answers of women and men, the value of women's responses would be adjusted upward to reflect their true proportion in the population, slightly more than 50 percent in the United States; the men's responses would be adjusted downward. Because most leading market research firms use pre-recruited panels, post-survey weighting is almost always necessary.

There are several aspects of our survey method that might affect generalizability. First, because our survey required respondents to have Internet access, we could not include people who did not have access. Currently, about 73 percent of American adults report having regular access to the Internet (Madden, 2006). The number of teen users is higher, 87 percent in 2005 (Lenhart et al., 2005). We recognize that people who do not have Internet access might have different views about engineering than those who do have access.

A second aspect of our survey method that might affect generalizability involves the participation of minorities in general-population surveys. Minorities have traditionally been less likely to respond to sample surveys. Factors that may explain their underrepresentation include disengagement from the issues, lower levels of literacy, and inadequate contact information, which makes it less likely that they will be included in sampling frames (Sheldon et al., 2007). Although the minority gap is closing (Crocket and Ante, 2007), it remains a problem for survey researchers.

Because one of our major goals is to develop messages that target traditionally underrepresented groups, we adopted a two-step

approach to overcoming the minority gap. The first step was to conduct an initial survey of the age groups of interest. Not surprisingly, African Americans and other minorities were underrepresented in this sample, as compared to the general population.

We, therefore, secured funding to field our survey in oversamples of African American and Hispanic respondents. The additional samples provided us with comparison groups to the general population. There were enough respondents in each group to make statistically valid inferences.

A third issue that may have affected generalizability was that NAE was identified as the sponsor of the research in the materials provided to survey respondents at the beginning of the questionnaire. This was necessary for securing fully informed consent from respondents, but it may also have influenced the responses to one or more questions. All of our results are interpreted with this caveat in mind.

Finally, in any survey, some people choose not to participate. The reasons for non-responses vary but can include disinterest in or aversion to the survey topic or discomfort with the survey methodology (e.g., keyboarding in an Internet-based survey). Because non-responses change the representativeness of a sample, the rate of non-response can affect generalizability. Some surveys—but not ours—try to correct for non-responses by contacting non-responders outside of the survey process to determine their reasons for not participating. Couper (2000) provides a good overview of this and other issues related to Web-based surveys.

DEVELOPMENT OF A POSITIONING STATEMENT, THEMES, AND MESSAGES

Ad hoc attempts by engineering organizations and others to promote a positive image of engineering, although well intentioned, have often fallen short, in part because most of the promoters do not have the knowledge or experience necessary to develop, test, and disseminate effective messages. A key premise for this project, therefore, is that the engineering community—and the committee itself—would benefit by involving communications and market-research professionals.

To find the best match between this project and a professional communications/marketing firm to carry out research, the National Academy of Engineering (NAE) developed a request for proposals (RFP) and posted a downloadable version on the NAE website in early April 2006. Notice of the solicitation was disseminated to approximately 100 market-research firms via the Researcher Sourcebook Directory (on the website for Quirk's Marketing Research Review, *www.quirks.com*). An additional 20 research and communications firms identified by a consultant to the project were notified directly. The maximum acceptable bid was set at $100,000, in keeping with the terms of the original proposal to the National Science Foundation (NSF).

Project staff conducted an initial screening of the 15 responses to the RFP to assess the qualifications of the responding organizations. The screening criteria related to the completeness of company descriptive information, appropriateness of the plan and personnel to carry out the research, relevant past work, and pricing information. Six of the 15 met enough of the evaluation criteria to advance to a second round of review, this time by the project committee, which conducted in-person interviews and then made a selection—the team of Bemporad Baranowski Marketing Group (BBMG; *www.bbmg.com*), a communications firm, and Global Strategy Group (GSG; *www.globalstrategygroup.com*), a market research company.

COMMUNICATIONS AUDIT

Developing a vision for new messages requires knowledge of past and current efforts. With that in mind, BBMG and GSG (BBMG/GSG) conducted a communications "audit," a wide-ranging review of previous messaging research (e.g., Davis and Gibbin, 2002; EWEP, 2005; Harris Interactive, 2004, 2006) and the kinds of communications materials that were being used to promote engineering in the public arena (e.g., by National Engineers Week, *www.eweek.org*). The results of the audit, described below, were discussed with the project committee and used to inform plans for qualitative and quantitative research.

The audit confirmed much of what had been reported in *Raising Public Awareness of Engineering* (NAE, 2002).

- **Ad hoc efforts.** Up to now, engineering outreach and message development have been mostly ad hoc. Few organizations or communicators have used written strategic communications plans.
- **Scant data on outcomes.** Measuring outcomes has been difficult, largely because of the ad hoc nature of current efforts. Very few organizations have used metrics that produce results that can be tracked, although most of them believe their programs are successful.

- **Lack of coordination.** Outreach efforts have been poorly coordinated or not coordinated at all. Nevertheless, there is a strong desire in the engineering community for a coordinated campaign, especially in terms of communicating the contributions of engineering to people's welfare and the career benefits of engineering. However, coordination has been stymied by lack of clear leadership, limited resources, and inadequate infrastructure.
- **Few attempts to reach youngsters.** Most outreach initiatives have targeted older students (i.e., high school students) in an effort to prime the engineering education "pipeline." Less attention has been paid to elementary and middle school students, when stimulating interest in engineering might also serve a "mainline" function, namely promoting technological literacy and increasing interest in mathematics and science.
- **Local outreach.** With a few exceptions, notably National Engineers Week, most outreach programs have been local. National Engineers Week is considered one of the most effective outreach efforts, although no data have been collected showing changes in student attitudes about engineering or interest in pursuing engineering as a career.
- **Diverse approaches.** Engineering outreach efforts have used a variety of tactics and approaches, including design-and-build competitions, mentoring programs, and tool kits for teachers and guidance counselors. This wide variety of activities has made it difficult to deliver a consistent message and contributed to inconsistent messages, even from a single organization.

In general, messages targeting younger children attempt to convince them that mathematics and science are easy and fun and that engineering is challenging, exciting, hands-on, and rewarding work. Encouragement ("You can do it!") is a common undercurrent. Messages for older, prospective college students tend to reinforce the excitement and rewards of an engineering career (engineering prepares you for success and gives you opportunities to use your knowledge in

creative ways that will improve people's lives). For the most part, messages that promote engineering have been direct, rational statements emphasizing the *benefits* of engineering. Typical messages for students include:

- An engineering education is a sound basis for a career.
- Engineering offers challenges, excitement, opportunities, and satisfaction.
- Engineering is worthwhile, challenging, fun, and within reach.

A second recurring theme has been to link engineering to *skills* in mathematics and science. These messages frequently suggest that students must have a high aptitude and strong interest in these subjects to succeed in engineering.

As part of information gathering for a planned larger messaging effort (ultimately funded by NSF and described in this report) NAE in April 2005 brought together several advertising and public relations (PR) professionals with decades of experience in engineering or technology-related campaigns to discuss current and past messaging. This small focus group, funded by the S.D. Bechtel, Jr. Foundation, recommended that certain kinds of messages be avoided:

- *Math and science are fun or easy.* The challenge of studying math and science should not be trivialized, because engineering does require proficiency in these subjects.
- *Engineers improve the quality of life.* This message is not unique to engineers and may not be readily believable.
- *Engineers design and build things.* Although this is what engineers do, the message does not do justice to the importance of engineering.

At the end of the discussion, the group identified the following categories for the development of messages:

- *Engineers are necessary*. Emphasize the critical importance of engineering accomplishments.

- *Engineers have answers.* If not, they are the ones who can find answers.
- *Engineers/engineering make(s) things happen or make(s) things better.*
- *Engineers connect things.* Engineers link creativity and practicality.

The BBMG/GSG audit also reviewed a message-development project undertaken by the Extraordinary Women Engineers Project (EWEP). From June 2004 to January 2005, EWEP conducted focus groups, online and in person, as well as surveys of high school girls, teachers, and school counselors; engineering students; and professional engineers (EWEP, 2005). The goal of the project was to determine girls' perceptions of engineering and the perceptions of the people who influence them. The overarching conclusion of the project was bleak (EWEP, 2005):

> High school girls believe engineering is for people who love both math and science. They do not have an understanding of what engineering is. They do not show an interest in the field, nor …think it is 'for them.'

The report went on to note a disconnect between the messages being conveyed by the engineering community and the key career and academic motivators for girls (Figure 2-1).

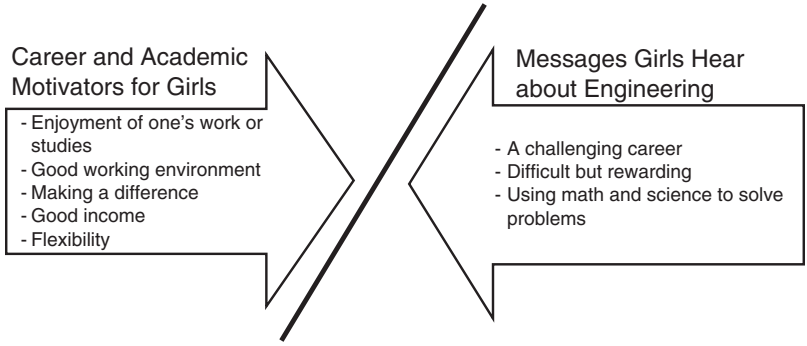

FIGURE 2-1 Differences between known motivators for career choices by girls and messages from the engineering community.

REFRAMING THE IMAGE OF ENGINEERING

Based on the communications audit and discussions with the committee, BBMG/GSG advised us to reframe the way engineering and engineers are presented to the public. They recommended that we stop talking about engineering primarily in terms of benefits to the individual and required skills and focus instead on ideas and impact.

Strategic Elements of an Effective Message

Make It Personal

To bring the experience of engineering to life, the message should ascribe authentic, vibrant personality traits to *engineers*. Engineers themselves should be central to the reframed image of engineering. They work with people, not abstract fields of study or career pursuits.

The message should include humor, wit, and irony to convey a human quality to the tone and voice behind the message. Messages that break through the clutter must make an emotional connection with their audiences, especially a young audience. The message should use *their* language, not impose *our* language. Language and word choices have a direct bearing on the emotional appeal of a message.

Show, Don't Tell

From a marketing perspective, labeling something as "cool" sounds a death knell, especially when kids and teens are the targets. Messages should be evocative rather than didactic. They should use metaphors, analogies, and symbols whenever possible. Messages should be embedded in stories that dramatize the rich legacy of engineering achievements.

Engineering messages can be effective on television because engineering lends itself to visual images. Yet, most current images reinforce the stale, one-dimensional image of engineers as operators and builders. At some point, a robust visual inventory should be developed and a serious investment made in developing an updated gallery of images.

Find "Campaignable" Ideas

Given the diverse activities and careers encompassed in engineering, testing *campaignable* ideas was essential during the research phase of the project. A campaignable idea is derived from an overarching theme with enough emotional relevance and power to connect a broad range of specific messages. It represents a unifying concept, the tip of the iceberg, and gains traction by virtue of a strategic, integrated marketing and communications effort and enough time and resources to move the needle of public awareness and change attitudes. Campaignable ideas can be readily adapted to appeal to different audiences and meet different needs. [1]

Find (and Mind) the Perception Gap

Perhaps the most important prerequisite for reframing the image of engineering is having a clear understanding of the perception gap we are trying to close. To communicate the unique values of engineering, our consultants recommended we shift negative perceptions to more positive ones (Table 2-1).

DEVELOPING A POSITIONING STATEMENT

Behind every powerful brand is a positioning statement that serves as a compass or guideline, pointing the way to the development of a robust communications program. As a guide to changing the perception of engineering from a profession that yields personal *benefits* and requires certain *skills* to a profession based on creative *ideas* that have a beneficial *impact*, BBMG/GSG developed, and the committee endorsed, the following positioning statement (Box 2-1):

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[1]Several recent campaigns have shown that seemingly fragmented industries, in which coordination seemed a distant reality, can rebrand themselves and cultivate new identities that shift public perceptions. A few examples of successful industry rebranding campaigns include cotton ("The fabric of our lives."; *www.thefabricofourlives.com*), milk ("Got milk?"; *www.bodybymilk.com*), beef ("It's what's for dinner."; *www.beefitswhatsfordinner.com*), and pork ("The other white meat."; *www.theotherwhitemeat.com*).

TABLE 2-1 Suggestions for Changing the Perceptions of Engineering

From Current Perceptions	To New, More Positive Perceptions
Builders, operators, planners, and maintainers	Designers, creators, and inventors
Computer people	Many types of engineers
Geeks and nerds	Creative professionals, "imagineers"
White males	People of all backgrounds
Boring	Dynamic and exciting work that makes a difference
Too difficult to learn	Challenging but worth the effort
A man's job	Engineering is a field for men and women
Not as prestigious as a scientist	A prestigious job that helps make the world a better place
Less lucrative than law or medicine	Supports a very comfortable lifestyle

BOX 2-1
A Positioning Statement for Engineering

No profession unleashes the spirit of innovation like engineering. From research to real-world applications, engineers constantly discover how to improve our lives by creating bold new solutions that connect science to life in unexpected, forward-thinking ways. Few professions turn so many ideas into so many realities. Few have such a direct and positive effect on people's everyday lives. We are counting on engineers and their imaginations to help us meet the needs of the 21st century.

A strong positioning statement like this one is necessary for several reasons. First, it is a point of reference for all public communications (e.g., advertising, PR campaigns). Second, it encourages a consistent message (i.e., staying on message). Third, it clarifies the aspects of engineering that set it apart from other professions. Fourth, it makes a clear case for why engineering matters.

As noted in Chapter 1, a positioning statement is the conceptual foundation for a communications campaign, but it is not usually

shared with the public. However, even though the text of a positioning statement never appears in external communications, all messages and taglines are directly linked to it.

In Chapter 1, we pointed out that positioning statements answer a number of core questions about the "brand." Here is how the proposed statement aligns with those questions:

> No profession unleashes the spirit of innovation like engineering *(who).* From research to real-world applications *(what business),* engineers constantly discover how to improve our lives *(special needs)* by creating bold new solutions that connect science to life in unexpected, forward-thinking ways *(unique benefit).* Few professions *(competitors)* turn so many ideas into so many realities *(the difference).* Few have such a direct and positive effect on people's everyday lives. We *(who served)* are counting on engineers and their imaginations to help us meet the needs of the 21st century.

Preliminary Themes and Messages

Guided by the positioning statement, in consultation with the committee, BBMG/GSG proposed six preliminary themes and sample messages—three focused on engineers and three on the engineering profession. The messages were later refined based on qualitative research (i.e., focus groups and triads), the next phase of the project (described in Chapter 3).

Themes/Messages Focused on Engineers

Limitless Imagination

- Engineers are "imagineers." They see possibilities. They dream about making things better.
- Engineers are curious. They ask questions, "How does it work?", "Where does it go?", "What will happen if?"
- Engineers are creative problem-solvers. Like artists, engineers have a vision of how something should work, and they are passionate about that vision.
- It takes teamwork to bring creative ideas to life. Engineers work with other smart, imaginative people, such as animators, architects, astronomers, chemists, physicians, meteorologists, and physicists, to design and create new things.

Enterprising Spirit

- Engineers like to invent things. They create new products, imagine new gadgets, and launch new companies to turn their ideas into reality.
- Engineers are nimble and quick, able to think on their feet and work wonders using the tools and technologies available to them.
- Engineers understand the practical applications of their work, how it will make a difference in people's everyday lives.

Free to Explore

- Engineers love to explore and discover. They see life as a journey, a quest for better ideas. Engineers dream up smarter robots, faster sports cars, new medical devices, and ways to reduce pollution.
- Engineers think outside the box. They take things apart to see how they work. They are constantly learning new things.
- Engineers are never bored. They adventurously seek out problems that need solving. They are constantly being challenged and inspired to keep exploring.

Themes/Messages Focused on Engineering

Ideas in Action

- Engineering bridges the world of science and the real world. It turns ideas into reality.
- From the grandest skyscrapers to microscopic medical devices, engineering plays a role in almost everything we experience.
- Engineering is on the cutting edge. Engineers use the latest science, tools, and technologies to advance society and improve people's lives.

Shape the Future

- Knowing how to turn dreams into reality is totally empowering. It's a skill that lasts a lifetime.
- As an engineer, you can shape your future and the world's future. You can help solve tomorrow's problems today.

- Engineering offers many lucrative career options in research, development, design, construction, sales, and management. It's worth the hard work it takes to become an engineer.
- Engineers say that seeing their ideas come to life, having a direct effect on people's everyday lives, is far and away the most rewarding aspect of the job.

Life Takes Engineering

- Engineering could not be more relevant. Our society is becoming increasingly complex. We must provide more food and energy for a rapidly growing population, and we must limit damage to the environment in the process. Engineering will play a big role in meeting these challenges.
- Engineering is good for our economy. It's big business, and it provides millions of jobs. It makes this country stronger, safer, and more competitive.
- Engineering makes a world of difference. From new medical equipment and safer drinking water to faster microchips, engineers apply their knowledge to improve people's lives in concrete, meaningful ways.

Each of these messages and themes can be traced back to the positioning statement. For example, the "Limitless Imagination" theme describes engineers as curious and visionary, as creative problem-solvers who want to make things better. This connects to the description in the positioning statement of engineers as focused on discovery, innovation, and creative solutions. The "Ideas into Action" theme suggests that engineering is a bridge between the world of science and the real world and is responsible for the technological improvements we enjoy. This theme connects to the notion of engineers turning ideas into reality, with direct, positive effects on people's lives.

CONCLUSION

The communications audit conducted by BBMG/GSG identified recurring themes in current messaging and collected useful, although limited, data on what adults and teens think about the engineering

profession. Through an iterative process between the consultants and the committee a new more powerful vision of engineering emerged and was encapsulated in a positioning statement (Box 2-1). Several themes and messages based on that statement were developed by BBMG/GSG in consultation with the committee.

Positioning statements are the core of successful marketing campaigns. In the case of engineering, the proposed positioning statement represents a dramatic shift in point of view. The focus is no longer on required skills and personal benefits. Instead, the emphasis is on the connection between engineering and ideas and possibilities.

The new statement is an optimistic, aspirational expression of a field that has, up until now, been portrayed in much more pedestrian terms—a math- and science-dependent process for solving problems. Engineering is that, of course, but it is also much more. It is inherently creative, concerned with human welfare, and an emotionally satisfying calling. In short, the new positioning statement changes the conversation about engineering.

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RESEARCH RESULTS

The communications audit provided a comprehensive overview and critique of the strategic approaches and tactics used to date to communicate with the public about engineering. Combined with input from the committee, the audit gave the consultants a solid basis on which to develop a positioning statement and preliminary themes and messages. The consultants then conducted qualitative and quantitative research, which added to our knowledge of stakeholder perceptions of engineering, vetted preliminary messages, validated the positioning statement, and provided an evidence base for recommendations.

The qualitative research comprised individual interviews, adult and teen focus groups, and "triads" (groups of three) with preteens. The quantitative research consisted of an online survey. Consistent with federal rules for research on human subjects, the National Academy of Engineering established procedures, including informed consent, to ensure the confidentiality of research participants. This process was overseen by the National Academies Institutional Review Board.

QUALITATIVE RESEARCH

Qualitative research involving small samples selected without using statistical procedures must be considered exploratory, and the resulting hypotheses may have to be validated by quantitative research. Qualitative research can sometimes provide clear conclusions but is designed primarily to shed light on perceptions of the issues in question, in this case engineering and engineers.

In-Depth Interviews

In the first phase of the qualitative research for this study (September and October 2006), Bemporad Baranowski Marketing Group/Global Srategy Group (BBMG/GSG) conducted 12 in-depth interviews of a cross section of educators, opinion leaders, and engineers. By talking with individuals familiar with engineering, BBMG/GSG hoped to confirm and build on the conclusions of the communications audit and discussions with the committee. The interviewees were the first group outside of the committee to weigh in on the messages and themes.

Methodology

The interviews were conducted by telephone and tape recorded to ensure that they were reported accurately. Each interview lasted 45 minutes to an hour. (An interviewer's guide can be viewed at Appendix B.) The project committee and staff suggested potential interviewees, but BBMG/GSG made the final selection. In keeping with the informed-consent process, the identities of the interviewees were not revealed to the committee or project staff.

Key Findings

Perceptions of Engineers and Engineering. The interviews revealed a wide gap between the way engineers would like themselves and their field to be perceived and the way both are actually perceived. At best, engineers are seen—and see themselves—as curious, hard-working

individuals who design solutions to difficult problems and leave their mark on the world. As the chair of a university chemical engineering department said, "They [engineers] are the interface between society and technology."

However, engineers can also be very hard on themselves. Sometimes they describe themselves and others in engineering as "Dilberts", that is, "book smart," "nerdy" "know-it-alls" who are "isolated," "myopic," and "not cool." Some argue that this stereotype is unfair and have criticized their peers for not doing a better job of explaining exactly what engineers do. As a researcher in a corporate research and developoment division said, "Engineers are seen as nerds and geeks. People who are not in it [the field] have a hard time grasping what we do, [and] we don't do a good job of explaining it either. It [engineering] is seen as a bunch of technical things they can't grasp . . . and boring, too."

Many interviewees noted that there is no readily identifiable "public face" of engineering, no personality, such as Julia Child for cooking, Oprah Winfrey for talk television, Tiger Woods for golf, or Martha Stewart for home living. Some felt that cable TV programs that explain "the way things work" or feature engineering "marvels" expose many more people to a positive image of the field than the best-organized "engineering fair" or "popsicle-stick bridge-building contest," which only attract people who are already interested in engineering.

Interviewees who are engineers expressed concerns that the contributions of engineering to everyday lives are taken for granted. To an observant eye, engineering is all around us, but it takes a "powerful awareness" to be able to see it. A columnist for a major newspaper said, "Engineering is the behind-the-scenes job that no one pays attention to, and it doesn't have to be that way."

Several interviewees said that the lack of diversity in engineering is a significant issue. "If anything, I'd like to make it [engineering] more appealing for minorities and women," said a Ph.D. candidate and member of the National Society of Black Engineers. As noted in Chapter 1, women and some minorities are significantly underrepresented in engineering education and practice.

One reason for the difficulty in communicating effectively with the public is that the technical aspects of engineering—especially

mathematics and science, which are perceived as difficult—are usually emphasized, rather than the creative opportunities. As a vocational instructor and middle school technology teacher explained, "Students don't …understand that [engineering] is really a super-creative job. They don't see that [engineers] are probably more artistic than some artists. [Engineers] are just using a different set of paints, if you will."

Reactions to Messages. All of the preliminary messages and themes (Box 3-1) were well received, except for "An Enterprising Spirit" and "Free to Explore." Both engineers and educators embraced the image of engineering as creative, imaginative problem-solving and overcoming "seeming impossibilities."

Focus Groups and Youth Triads

In mid-October 2006, BBMG/GSG conducted four focus groups with young people ages 12 to 15 and 16 to 19 (one in each age group in Raleigh, North Carolina, and in Phoenix, Arizona) and a single focus group with parents of young people ages 9 to 19 in Raleigh. BBMG/GSG also conducted four same-sex youth triads with children ages 9 to 11 in Phoenix.[1]

The purpose of the focus groups and triads was to explore teens and children's understanding of engineering, their impressions of engineers, and their reactions to examples of engineering and messages about engineering. In addition, the student groups were asked their opinions on current school subjects and their ideas about future careers. The parent group was asked what they thought was important in career choices for their children.

[1]One-on-one interviews with young children are notorious for causing respondents to "shut down," and focus groups with young children are similarly unproductive. In triads, the three friends already have a rapport and are accustomed to playing and talking with each other. All qualitative methods will introduce some bias, and with triads there may be a "pecking order" effect. GSG has conducted youth triads with great success for such clients as the Boy Scouts and Scholastic.

BOX 3-1
Reactions to Preliminary Messages, Selected Quotes

Ideas in Action (underscores that engineering bridges the world of science and the real world).

"That's what engineering does. That's what got me into engineering. I didn't want to go into chemistry. I thought engineering was more practical."

Chemical engineer, international industrial gas company

Life Takes Engineering (focuses on the life-changing work of engineers).

"No kidding. Life does take engineering. [The word] *life* adds depth to the subject. It speaks to people on all levels. It speaks to people who aren't as fortunate [as we] to have the greatest environment to live in. It gives them aspirations for greatness. It's changing your life for the better."

Vocational instructor and middle school technology teacher

Limitless Imagination (focuses on the innovative nature of engineering design).

"Creative ideas often lead to elegant solutions, like the Segway."

Computer architect, major semiconductor company

Free to Explore (evokes the constant journey, the engineer's quest for new solutions).

"Is that always true? Is it always a new solution you're looking for, or is it to take existing solutions and apply them in certain circumstances?"

Columnist, major newspaper

Shape the Future (engineering as an empowering, rewarding career).

"You're talking about making a difference in so many ways: from artificial limbs to XBox 360."

Ph.D. candidate, National Society of Black Engineers

An Enterprising Spirit (the inventive spirit and pioneering contributions of engineering).

"[The word] *enterprising* conveys much more of a business aspect, and kids won't understand that until later. It gives a business flavor, so I'm not sure about that one."

Planner, NASA

Methodology

Focus group respondents were recruited by telephone by professional recruiters calling from a residential telephone list. Respondents were eligible only if they had not participated in a market research group discussion, focus group, or individual interview in the previous six months. Adult participants were parents of children in school ages 9 to 19 who were "planning to attend or . . . currently attending college." Adult respondents were informed that the project consisted of an informal discussion group "to learn more about how parents feel regarding various issues that impact their child's education and career choices." All teen respondents were currently "planning to attend or . . . currently attending college." Teens were informed by recruiters that the discussion groups were being conducted "to learn more about how young people feel about their education and career choices." Teens ages 16–18 were eligible to participate only if they had not already chosen to pursue a specific, non-science-related career, or if they might change their mind about a chosen career. Teens were also asked for their opinions about several possible professions or career choices they may choose, and asked if they thought that profession or career choice would be a very good choice, a good choice, a fair choice, or a bad choice for them. Teen respondents were ineligible to participate if they believed engineering was a "bad choice" for them, personally.

A total of 28 teens, 12 pre-teens, and 10 adults participated in the focus groups and triads. According to demographic data collected by BBMG/GSG, between 20 and 50 percent of individuals in each focus group considered themselves minority (i.e., non white). Participants were recruited and screened by local research firms selected by the consultants, and the sessions were held at the facilities of the local firms in rooms with one-way mirrors, which enabled consultants and project staff to observe the discussions without distracting the participants. Committee members and project staff who were not onsite were able to observe the sessions in Phoenix via video on a password-protected website.

The focus sessions lasted about two hours and were professionally moderated according to committee-approved discussion guides (see Appendixes C and D). Participants received a small financial incentive and were required to sign informed-consent forms.

Triads lasted from 45 minutes to an hour, and moderators again used a committee-approved discussion guide (Appendix E). Like the focus groups, the triads were held in rooms with one-way mirrors. The general format was the same as for the teen and adult focus groups, with one exception. Children were asked to react to engineering-related pictures rather than to respond to the message themes directly. Parents signed consent forms on behalf of their minor children.

Findings

Perceptions of Engineers and Engineering. Students struggling to understand the concept of engineering—especially younger children and older children with little interest in math, science, or computer games—connected the word "engineering" to the word "engine" and thus concluded it had something to do with vehicles, such as cars, trains, and army tanks. One Phoenix teen in the 12–15-year-old group thought engineering must be "being able to fix things that are part of the engine."

Other researchers have also found that children have a relatively narrow idea of engineering (Cunningham et al., 2005). The majority of students understood that engineers "design and build things" but tended to have a very limited idea of what that meant, focusing mainly on mechanical or structural aspects of engineering, like cars, bridges, and buildings. One teen in Raleigh had a more comprehensive view. Engineering, he said, is about "designing buildings, making blueprints, making stuff work . . .Taking things apart and putting them back together better, like electronics . . . Making new products that are more efficient, like a trash can that can go to the curb by itself."

When the moderators explained (via written examples for the teen groups and pictures for the preteens) that engineering is all around us, the students became much more interested in engineering as a possible field of study. The examples helped them understand the broad reach of engineering, how it benefits society, and how it might be connected to something that interests them. "If you told somebody that they could invent the next Xbox, you'd get a lot of kids who'd want to be an engineer," declared a teen in the 12–15-year-old focus group in Phoenix.

Students who were most aware of engineering—older children, particularly if they had a parent or family friend or relative who was an engineer, and students who already had a strong interest in science and math—included computers and technology, space exploration, traffic and city planning, and other topics in their definitions. Even these students, however, were not sure of the role of engineering in actual projects. In fact, even the few students who said they planned to become engineers had little understanding of the kinds of tasks involved in performing a job or pursuing a career.

When asked to describe the qualities of engineers, students tended to emphasize that engineers were "smart," "imaginative," and good at math and science when they were kids. Although they did not have a negative impression of engineers, many seemed to feel that they themselves were not smart enough or did not enjoy math or science enough to become engineers. One preteen commented, "Certain kids can become engineers. If dumb kids try to become engineers, it isn't going to work well. [Engineering is for] smart kids who know how to fix things . . . For cars, you need to know math and science, how this plus this equals mileage."

If some students thought that engineers were smart, creative, and imaginative, many others thought they were sedentary, worked mostly on computers, and had little contact with other people. "Seems like a lot of engineers sit behind a desk and don't do much field work," said one Raleigh teen in the 16–19-year-old group. "It's a desk job. I'd beat my head against the wall if I had to do that . . . When you think of engineering, you don't think about being in front of people."

Nearly all of the girls who took part in the research said they thought women could be engineers as well as men. However, there was a strong underlying assumption that girls "who like things that boys tend to like" (e.g., video games, cars and vehicles, building things) were more likely to become engineers than "average girls" (e.g., girls who want to be veterinarians, lawyers, doctors, fashion designers, teachers, or otherwise want to "work with people").

When asked to name engineers they knew or had heard of, including those who had visited their schools on career days, most students could name only men. Almost everyone—students and parents of both

genders—agreed that no concerted efforts had been made to engage women in engineering or to demonstrate to girls how science, math, and engineering are related to the things they are most likely to care about.

Examples of Engineering. Students were asked to review a list of examples of engineering (Table 3-1) (for focus groups) or pictures of engineering-related artifacts or people engaged in activities (for triads) and pick the examples they found most interesting or appealing. The results showed that students tended to pick examples of the things they "connect with" personally. This suggests that a broad variety of examples would appeal to a very wide range of children, as long as the examples include concepts related to students' interests.

TABLE 3-1 Examples of Engineering Shown to Students in Focus Groups

- How the pyramids were built
- Space
- Designing video games
- Building an acoustically perfect concert hall
- What makes a bridge
- Building the world's tallest bridge (over 1,000 feet high)
- Designing the world's fastest plane
- Developing new foods
- How MRI machines work
- DNA testing
- Using DNA evidence to solve crimes
- Cars that run on alternative fuels
- Making cars safer
- Growing organs for emergency transplants
- Making smaller, faster computer processors
- Protecting the rainforest
- High-speed (250 mph) trains
- Developing new fabrics
- Automotive design
- Computer-aided design
- Missile defense systems
- Interactive television
- Traffic design
- High-definition television
- Nuclear fission
- Internet security systems
- iPod
- Making homes safer
- How a million Twinkies are made every day
- How tower cranes work
- Velcro
- High-speed image transmission
- High-performance racing cars
- Turning deserts into farmland
- Wind power
- Solar energy
- Machines that allow blind people to see

Examples of objects and activities children were familiar with in their daily lives stimulated the most interest. For example, students repeatedly expressed enthusiasm for video games, iPods, computers, cell phones, and amusement parks. High-tech devices, such as the iPod and video games, were picked by a broad range of children, while pictures of the microchip were picked mostly by science- and math-oriented students. Some students found images and descriptions of space exploration interesting, while others gravitated more toward historical examples of engineering (e.g., catapults or pyramids).

Younger girls tended to pick images that showed people, particularly older female engineers, while boys were more likely to pick images that featured "things." This finding is consistent with other research on thing–people orientation among girls and boys (e.g., Lippa, 1998). Many older girls seemed to gravitate toward "DNA evidence" from the list of examples. Young students did not select pictures of individuals standing still or sitting at a desk, which reflected their image of engineering as "boring or repetitive" and "not with other people."

Reactions to Message Themes. Students generally reacted positively to the message themes. They especially liked descriptions of engineers as "creative problem solvers" and "free to explore." The creative aspect of engineering "grabbed me," said one Raleigh 16–19-year old. "[T]hat appeals to me a lot more than trying to describe them as scientists . . . The never-ending part appeals to me . . . there's so much you can do with [engineering]." One Raleigh 12–15-year-old student liked the theme suggesting "that you'll never be bored. Keeping interest is the best thing in a job . . . Makes it sound like an adventure . . . something I wouldn't mind sitting through two calculus courses for."

Students expressed a very strong sense of the importance of choosing careers that will provide financial stability and a comfortable lifestyle. The career goal named most often was "making good money." Another concept that had strong appeal as a career goal was "helping to make a difference." However, many students found it difficult to connect engineering and helping others.

Most students thought that engineers might make a difference, but only *indirectly*, whereas doctors and lawyers, who have direct contact

with others, have a more obvious impact on people. "Engineering is behind the scenes helping people," observed a 16–19-year-old Raleigh student. "They design the machines that help people. You don't think of an engineer when you see a building or machine, you think that is a great machine. But when a doctor does something, you know that they did it."

This perception may explain why very few students associated major engineering challenges for the next generation (e.g., "cars that will help us achieve oil independence" or "saving the rainforest") with "making a difference." Several students also hinted that a career in engineering might not fulfill their desire for recognition. This idea was based on a conception that engineers draw more satisfaction from individual or team-oriented work than from direct recognition or the gratitude of users or beneficiaries.

Parents. Most parents said that engineering would be a good field for their children to consider. Even those who were not certain about what engineers do were confident that engineering would provide job security—a top priority for parents—in the form of good salary and benefits, as well as a career path for advancement and success. "You can test waters in different disciplines within engineering. It is a good career choice," said one parent.

Parents had a mixed perception of engineers, however. On the one hand, they saw them as very smart problem solvers whose work is critical to society. On the other hand, they perceived them as somewhat nerdy and, perhaps, too focused on understanding how things work or trying to make things more efficient. As one parent said, "I think it is a certain personality type. I know it is a stereotype, but I think [engineers] tend to see things more black and white.…Very precise, detail oriented, they are not going to get into a conversation about politics or news."

In the discussion of message themes, parents tended to prefer the practical messages, underscoring their interest in job security for their children. They strongly agreed that "creative problem solving," "freedom to explore," and "making a difference" would appeal to their kids, but they were more intent on making sure their kids find a career that

will keep them financially secure. "Tell them to find something that is reasonably satisfying and you can make a living at," counseled one parent.

QUANTITATIVE RESEARCH

Once the information provided from the communications audit and qualitative research had been digested, the committee moved to obtain quantitative data, which are important for at least two reasons. First, they provide a check on the findings and interpretations of the qualitative research. Second, they provide a statistically sound foundation for making a case for new messaging to present to the engineering community.

Methodology

The online survey was administered in two phases: to an initial sample of teens and adults in December 2006 and two oversamples of African American and Hispanic teens and adults in spring 2007. The survey instrument (Appendix F), which was developed by BBMG/GSG in an iterative process with the committee, included six questions about views of engineering and engineers and four questions about reactions to messages and taglines. Some of these questions asked respondents to rate or choose among multiple answers. To avoid the possibility that the choices at or near the top or at or near the bottom of the list would be preferentially selected (so-called order effect), the order of answers was randomized for each respondent.

Adults in all three samples were asked about their level of interest in the news and engagement in the community. This information was used to create a category of "informed adults," individuals with some college education who said they either followed the news on an ongoing basis, including local, state, and national political developments, or were involved in their communities as volunteers.

For the initial sample, GSG fielded the questionnaire in a panel recruited by Polimetrix (*www.polimetrix.com*). The survey was completed by 1,234 individuals, 666 adults (including an oversample of 200 informed adults) and 568 teens, ages 14 to 17. As noted in Chapter 1,

there were relatively few African Americans and Hispanics in the initial sample (only 77 non-white adults and 116 non-white teens); thus, statistically speaking, it was impossible to draw valid conclusions about the responses of these groups.

Because African Americans and Hispanics are a key audience for engineering messaging, the committee decided to enlarge the survey sample to include these populations. The oversampling was conducted in late May and early June 2007 by Harris Interactive (*www.harrisinteractive.com*) and returned 605 surveys from African American adults, 608 surveys from Hispanic adults, 535 surveys from African American teens, and 566 surveys from Hispanic teens. Like BBMG/GSG, Harris Interactive relied on pre-recruited panels of respondents. All survey samples were statistically weighted to adjust for potential demographic differences between the final sample and the general population.

When interpreting the results of the online survey, it is important to keep in mind that data for the initial and African American and Hispanic samples were obtained at different times and data were collected differently. Although every effort was made to ensure that the wording and order of the questions were the same for all the samples, other variables, such as the visual presentation, could not be as easily controlled. In other words, the mode of data collection may have influenced responses.

For this reason, the committee's analysis is focused on relative rankings *within* each sample, rather than potentially misleading differences *among* samples. The ranking numbers (in parentheses) in the tables that follow should be interpreted cautiously, because when the point spread between two percentages was smaller than the sampling tolerance,[2] it was impossible to determine relative rankings of the responses.

[2]The sampling tolerances for comparing adult and teen samples and for comparing gender samples ranges from 4 to 10 percent, depending on the survey response percentages and the sizes of the samples. In the tables that follow, the committee has shaded data for which the differences exceeded the sampling tolerances.

Assuring Socioeconomic, Educational, and Geographical Representativeness

Surveys such as ours need to be sensitive to the diversity of the U.S. population, because people from diverse backgrounds may not share the same views on engineering. For this reason, both GSG and Harris sought participation of teens and adults from a range of income, educational, and geographic backgrounds. As a result, our data reflect input from important subpopulations, such as those of low income and limited education, and those living in rural regions of the country.

For example, income information collected in the two Harris surveys revealed 28 percent of African American adults and 34 percent of Hispanic adults had household income below the 2006 median for their race or ethnicity, $31,969 and $37,781, respectively (DeNavas-Walt et al., 2007). In 2006, median household income for white Americans was $50,673 and for all races it was $48,201.

No income data were requested of adults in the initial sample. However, it is possible to use information about educational attainment to estimate a person's socioeconomic status. In the initial sample, 39 percent of adults said they had no education beyond high school, and an additional 6 percent indicated they had not graduated high school. Median household income in 2005 for "householders" with no high school diploma was $24,675 and for those with no more than a high school diploma it was $38,191 (U.S. Census Bureau, 2006).

The socioeconomic status of teens in the African American and Hispanic oversamples can be estimated by their reporting of the educational attainment of their mothers and fathers. (No data regarding parental educational attainment were collected from the teens in the first survey.) These data suggest that a large minority of African American teens (between 37 and 41%) and a majority of Hispanic teens (between 52 and 57%) were from families where neither mother nor father had attended college.

Taken together, actual and inferred income data suggest that a significant proportion of adults and teens in the African American and Hispanic oversamples, and of adults in the initial sample, were of moderate to low income.

The online survey also collected geographically representative data. The initial sample and two oversamples interviewed individuals across four regions of the United States (East, Midwest, South, and West), and these data were weighted to approximate the geographical distribution of the population of the United States. In addition, Harris collected data from the two teen oversamples regarding the location of the school that respondents "currently attend or most recently attended." Approximately 50 percent of African American and Hispanic teens reported attending a school in an urban or city area; slightly more than 35 percent reported attending in a suburban area; and about 15 percent reported attending in a small town or rural area.

Perceptions of Engineering

Career Choice

When adults were asked to name a "very good choice" of career from a list of six professions, doctor, scientist, and engineer were nearly equivalent (Table 3-2). Teens put doctor at the top of the list and engineer, lawyer, or scientist second. With the exception of teens in the initial sample, teaching was at the bottom of the list.

In all of the teen samples, boys were nearly twice as likely as girls to rate engineering as a very good choice of career, and engineering was the only profession in which there was a difference between genders. This gender gap was even more dramatic in data collected by the College Board in 2006 for 1.55 million high school juniors who took the Preliminary SAT/National Merit Scholarship Qualifying Test. In those data, 14.7 percent of boys but only 2.0 percent of girls indicated they planned to major in engineering in college (College Board, 2007).

Survey takers were asked to rate the relative importance of seven factors (interesting work, availability of jobs in the field, work that makes a difference, challenging work, salary, recognition, and prestigious field) in career choices. Adults in the initial sample and Hispanic adults in the oversample rated interesting work and job availability equally as the two most important factors (Table 3-3). African American adults cited job availability as most important and interesting work second.

TABLE 3-2 Survey Respondents' Choices for "Very Good Choice" Careers, by Percentage (Rank)

	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
Career		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Engineer	56 (1)	24 (3)	34 (1)	17 (4)	58 (2)	27 (3)	36 (1)	19 (4)	61 (1)	29 (2)	39 (1)	20 (5)
Doctor	52 (2)	32 (1)	32 (3)	32 (1)	62 (1)	42 (1)	34 (2)	48 (1)	58 (2)	40 (1)	37 (2)	43 (1)
Scientist	50 (3)	*	*	*	54 (3)	23 (4)	25 (4)	22 (3)	50 (3)	22 (4)	21 (5)	23 (3)
Architect	37 (4)	17 (5)	19 (4)	16 (5)	50 (4)	19 (5)	23 (5)	16 (5)	45 (4)	20 (5)	22 (4)	17 (6)
Teacher	33 (5)	24 (3)	19 (4)	29 (2)	40 (6)	10 (6)	7 (6)	12 (6)	34 (5)	17 (6)	12 (6)	21 (4)
Lawyer	28 (6)	30 (2)	33 (2)	27 (3)	44 (5)	29 (2)	28 (3)	30 (2)	33 (6)	25 (3)	26 (3)	25 (2)

* Due to a programming error, "scientist" was not included as an answer choice for teens in the initial sample.
NOTE: Pairs of shaded cells indicate responses where differences exceeded the sampling tolerance and are therefore significant. Gray = adults vs. all teens. Black = boys vs. girls.

TABLE 3-3 Survey Respondents' Choices for "Extremely Important" Factors in Making Career Choices, Percentage (Rank)

	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
Factor		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Interest	48 (1)	65 (1)	63 (1)	66 (1)	50 (2)	62 (1)	59 (2)	64 (1)	49 (1)	59 (1)	56 (1)	63 (1)
Availability	48 (1)	28 (4)	32 (4)	24 (5)	61 (1)	45 (4)	42 (3)	47 (3)	48 (2)	37 (4)	36 (4)	38 (3)
Difference	41 (3)	47 (2)	45 (2)	49 (2)	46 (3)	48 (3)	38 (4)	56 (2)	46 (3)	51 (2)	46 (2)	55 (2)
Challenge	29 (4)	28 (4)	32 (4)	25 (4)	30 (5)	22 (7)	24 (5)	21 (7)	27 (5)	25 (5)	26 (5)	23 (5)
Salary	26 (5)	34 (3)	43 (3)	26 (3)	45 (4)	54 (2)	63 (1)	45 (4)	35 (4)	40 (3)	45 (3)	35 (4)
Recognition	10 (6)	14 (7)	13 (6)	15 (7)	18 (7)	24 (6)	23 (6)	25 (6)	15 (6)	24 (6)	25 (6)	22 (7)
Prestige	9 (7)	15 (6)	13 (6)	16 (6)	19 (6)	25 (5)	22 (7)	28 (5)	13 (7)	24 (6)	25 (6)	23 (5)

NOTE: Pairs of shaded cells indicate responses where differences exceeded the sampling tolerance and are therefore significant. Gray = adults vs. all teens. Black = boys vs. girls.

Adults in the initial sample classified as "not informed" were more than twice as likely as informed adults to believe salary was extremely important to career choice (35 vs. 16%). Among Hispanics, informed adults were significantly more likely than those in the not informed group to believe interesting work and challenging work were extremely important.

Teens universally rated interesting work as the most important factor in choosing a career. Making a difference was second most important among teens in the initial and Hispanic samples and as important to job availability for African American teens. When gender was taken into account, African American girls were significantly more likely than African American boys to look for a job that makes a difference. Salary was a strong second choice for African American teens and the top choice among African American boys, who were significantly more likely than African American girls to consider salary extremely important.

Familiarity with the Profession

Survey participants were asked to rate, on a scale of 1 to 10, how well they understood what people in the six professions do on a day-to-day basis (Table 3-4). Adults and teens were both most familiar with what teachers and doctors do for a living. This is not surprising considering how doctors and teachers are portrayed in the media and that people naturally come into contact with them. Engineer, architect, and scientist were much less understood, and among teens, engineer was either the least understood or was tied with scientist for that distinction. Boys in all three samples claimed greater familiarity with engineering than girls.

Informed adults in the initial and Hispanic samples claimed a statistically greater familiarity with engineering than their not informed peers. Men in all three samples asserted greater knowledge of engineering than the women.

TABLE 3-4 Familiarity with Professionals, from 1 ("Don't Know at All") to 10 ("Know Very Well"), Adults, Teens, and Teens by Gender, Mean Score (Rank)

	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
Professional		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Teacher	8.18 (1)	8.85 (1)	8.84 (1)	8.85 (1)	8.8 (1)	8.4 (1)	8.1 (1)	8.7 (1)	8.3 (1)	8.6 (1)	8.5 (1)	8.8 (1)
Doctor	7.35 (2)	7.28 (2)	7.3 (2)	7.26 (2)	8 (2)	7.6 (2)	7.2 (2)	8 (2)	7.6 (2)	7.2 (2)	6.9 (2)	7.5 (2)
Lawyer	6.65 (3)	6.33 (3)	6.61 (3)	6.09 (3)	7.5 (3)	6.7 (3)	6.5 (2)	6.9 (3)	6.9 (3)	6.3 (3)	6.1 (3)	6.4 (3)
Engineer	5.75 (4)	4.86 (6)	5.41 (5)	4.4 (6)	5.8 (6)	5.2 (5)	5.7 (5)	4.7 (6)	5.8 (5)	5.2 (5)	5.7 (5)	4.8 (6)
Architect	5.66 (5)	4.99 (5)	5.2 (6)	4.81 (5)	5.9 (4)	5.5 (4)	5.8 (4)	5.2 (4)	6 (4)	5.7 (4)	6 (4)	5.5 (4)
Scientist	5.34 (6)	5.46 (4)	5.68 (4)	5.27 (4)	5.9 (4)	5.2 (5)	5.3 (6)	5.1 (5)	5.6 (6)	5.2 (5)	5.1 (6)	5.3 (5)

Attributes of Engineers

In answer to the only open-ended question, respondents were asked to type the first word or words that came to mind when they heard the word engineering. The words mentioned most often (22 to 30% of the time) by adults were "builders," "building," and "construction" (Table 3-5). The second most frequent associations for adults in the initial sample were "math" or "science" (mentioned by 12%) and "design" (mentioned by 11%). Among African American and Hispanic adults, "math" and "science" were the second most frequent words associated with engineering. Teens across the board typed "math" or "science" most often (between 21 and 31% of the time). Informed adults in all three samples were significantly more likely than the not informed cohorts to associate math and science with engineering.

The prominence of math and science in the minds of the public was reinforced by responses to a second question in which respondents were asked to decide how well each of 25 attributes described engineering and/or engineers. Adults and teens chose "high skill level in mathematics and science" as the most distinguishing attribute of engineering (Table 3-6). Only in the Hispanic oversample was there a difference between the informed and not informed subpopulations in views about mathematics and science, with the former believing more strongly in the essentiality of such skills. A majority of adults and teens also chose "designers," "builders," and "problem solvers." More teens than adults chose "hard workers." African American women were more likely than African American men to believe engineers are well paid, hard working, and smart.

Although in the in-depth interviews, engineers said they believed the public viewed them as "boring" and "nerdy," fewer than 15 percent of adults or teens in the survey described engineers this way, although teens in the initial sample were three times as likely as adults in that group to consider engineering "boring" and twice as likely to consider engineers "nerdy."

Hispanic girls were significantly more likely than Hispanic boys to think engineers were nerdy and boring. When answer choices "very well" and "somewhat well" were combined, Hispanic girls were also significantly less likely than Hispanic boys to consider engineering fun.

Hispanic girls were also significantly less likely than Hispanic boys to believe engineering has a positive effect on people's lives. These findings suggest Hispanic girls may be an important audience segment to reach with messaging.

Examples of Engineering

Survey respondents were asked to rate the relative appeal of 27 technologies (Table 3-7). In general, technologies that have not yet been developed or are not in widespread commercial use were more appealing to adults and teens than technologies already in use. The development of machines to enable blind people to see, cars that can run on alternate fuels, safer cars, and improved medical imaging devices were considered "very appealing" by most adults and teens. Teens across the board found entertainment technologies, such as iPods and video games, more appealing than adults did.

Fabric technologies, Velcro®, and the development of new foods were relatively unappealing to both adults and teens. Although Hispanic boys found fabric technologies and Velcro® significantly more appealing than Hispanic girls did, these technologies were still at the bottom of the boys' list.

Among all teens, computer processors, video games, and high-definition television were significantly more appealing to boys than to girls. And girls in the initial sample and the African American oversample found the idea of using DNA evidence to solve crimes much more appealing than boys did. Boys in the initial sample were much more strongly attracted to space exploration than girls, and boys in the initial sample and Hispanic oversample found missile-defense systems more appealing than did girls in these groups.

Message Testing

After refinement based on the results of qualitative research, the committee tested five messages in the online survey (Box 3-2). Like the preliminary message themes, the refined messages are all derived from the positioning statement.

TABLE 3-5 Words Most Often Associated with "Engineering" or "Engineer" (chosen by 5 percent or more of respondents), Percentage (rank)

Words Associated with Engineering	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Builders/ buildings/ constuction/ bridges	23 (1)	16 (2)	17 (1)	15 (2)	29 (1)	21 (3)	23 (3)	19 (3)	30 (1)	25 (2)	25 (2)	26 (2)
Math/numbers/ physics/ computers/ science	12 (2)	21 (1)	17 (1)	23 (1)	17 (2)	27 (1)	24 (2)	30 (1)	19 (2)	31 (1)	35 (1)	28 (1)
Design	12 (2)	6 (5)	10 (4)	3 (6)	8 (4)	2 (10)	2 (10)	3 (9)	11 (3)	4 (11)	6 (9)	2 (11)
Mechanic/ machines/ industrial	5 (4)	13 (3)	13 (3)	14 (3)	10 (3)	23 (2)	26 (1)	20 (2)	10 (4)	21 (3)	21 (3)	21 (3)
Smart/skilled	5 (4)	1 (12)	2 (8)	1 (12)	5 (7)	2 (10)	1 (11)	3 (9)	7 (5)	3 (12)	3 (10)	2 (11)

Invention/ innovation/ creativity	5 (4)	3 (6)	2 (8)	4 (5)	5 (7)	3 (5)	3 (8)	2 (12)	6 (6)	6 (6)	7 (6)	6 (6)
Problem solving	3 (7)	3 (6)	5 (5)	* (12)	7 (5)	6 (6)	3 (8)	8 (5)	4 (9)	5 (8)	3 (10)	7 (5)
Electrical/ electronics	3 (7)	3 (6)	3 (7)	2 (7)	6 (6)	6 (6)	7 (6)	5 (7)	6 (6)	7 (5)	10 (5)	5 (8)
Complicated/ complex/difficult	2 (7)	2 (8)	2 (8)	2 (7)	3 (10)	2 (12)	* (12)	3 (8)	3 (10)	5 (8)	4 (12)	6 (6)
Cars/ Automotive/ trains	2 (10)	7 (4)	4 (6)	10 (4)	5 (7)	16 (4)	17 (4)	15 (4)	5 (8)	14 (4)	14 (4)	15 (4)
Technology	2 (10)	2 (8)	2 (8)	2 (8)	1 (12)	8 (5)	9 (5)	7 (6)	3 (10)	6 (6)	7 (6)	5 (8)
Makes things/ manufacturing	2 (10)	2 (8)	2 (8)	2 (8)	3 (10)	4 (8)	4 (7)	4 (8)	3 (10)	5 (8)	7 (6)	3 (10)

* less than 1%.

NOTE: Pairs of shaded cells indicate responses where differences exceeded the sampling tolerance and are therefore significant. Gray = adults vs. all teens. Black = boys vs. girls.

TABLE 3-6 Words That Describe Engineering "Very Well," by Percentage (rank)

Words that Describe Engineering	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Good at math/ science	86 (1)	84 (1)	85 (1)	84 (1)	77 (1)	71 (1)	59 (4)	81 (1)	72 (1)	76 (1)	74 (1)	78 (1)
Designs, draws, and plans things	61 (2)	63 (2)	64 (3)	61 (3)	67 (2)	59 (3)	60 (2)	59 (3)	60 (3)	56 (4)	61 (3)	50 (7)
Problem solver	59 (3)	62 (3)	68 (2)	57 (5)	60 (6)	52 (5)	58 (5)	47 (9)	64 (2)	50 (7)	47 (9)	53 (4)
Builds, constructs, and makes things	53 (4)	59 (5)	59 (4)	59 (4)	63 (3)	59 (3)	60 (2)	59 (3)	54 (4)	61 (2)	64 (2)	58 (2)
Creative	45 (5)	47 (7)	55 (7)	41 (9)	62 (4)	50 (6)	50 (6)	50 (7)	47 (6)	52 (5)	52 (6)	53 (4)
Get results	44 (6)	41 (10)	44 (9)	40 (10)	51 (8)	45 (8)	39 (8)	50 (7)	45 (8)	47 (8)	56 (5)	38 (11)
Well paid	44 (6)	46 (8)	48 (8)	44 (8)	61 (5)	45 (8)	32 (14)	56 (5)	53 (5)	51 (6)	52 (6)	51 (6)
Must be smart	43 (8)	56 (6)	58 (5)	54 (6)	46 (9)	37 (12)	35 (13)	38 (12)	45 (8)	42 (9)	38 (15)	45 (8)
Original thinkers	43 (8)	45 (9)	44 (9)	45 (7)	41 (12)	46 (7)	36 (9)	54 (6)	38 (13)	37 (12)	39 (13)	35 (12)
Hard working	42 (10)	62 (3)	56 (6)	66 (2)	56 (7)	64 (2)	63 (1)	65 (2)	47 (6)	58 (3)	58 (4)	58 (2)
Well respected	39 (11)	34 (14)	35 (15)	32 (13)	40 (14)	35 (14)	36 (9)	34 (16)	42 (10)	36 (14)	40 (11)	31 (13)
Work is rewarding	36 (12)	32 (15)	39 (13)	26 (15)	41 (12)	31 (17)	32 (14)	30 (17)	38 (13)	35 (15)	39 (13)	30 (14)

Mostly men	35 (13)	37 (12)	37 (14)	38 (12)	40 (14)	41 (11)	36 (9)	45 (10)	31 (15)	30 (16)	31 (17)	28 (15)
Have a positive effect	32 (14)	36 (13)	43 (12)	29 (14)	44 (11)	36 (13)	36 (9)	36 (14)	39 (12)	37 (12)	51 (8)	22 (17)
Inventors	28 (15)	41 (10)	44 (9)	39 (11)	46 (9)	43 (10)	45 (7)	40 (11)	40 (11)	42 (9)	40 (11)	43 (9)
Leaders	23 (16)	22 (16)	24 (16)	21 (16)	30 (17)	33 (16)	31 (16)	35 (15)	31 (15)	42 (9)	44 (10)	40 (10)
Often work outdoors	17 (17)	20 (17)	22 (17)	19 (17)	29 (18)	35 (14)	30 (17)	38 (12)	21 (18)	30 (16)	33 (16)	27 (16)
White	12 (18)	11 (23)	10 (22)	12 (22)	34 (16)	14 (21)	15 (20)	12 (21)	22 (17)	10 (23)	9 (22)	10 (24)
Entrepreneur	12 (18)	18 (18)	18 (18)	18 (18)	21 (19)	22 (19)	15 (20)	28 (18)	14 (21)	24 (18)	29 (18)	19 (19)
Too much school	10 (20)	15 (19)	15 (20)	15 (20)	16 (20)	14 (21)	17 (19)	11 (22)	18 (19)	13 (21)	12 (21)	15 (21)
Fun	7 (21)	9 (24)	6 (24)	11 (24)	15 (22)	15 (20)	12 (22)	17 (20)	13 (22)	19 (20)	24 (19)	14 (23)
Start new companies	7 (21)	14 (20)	16 (19)	12 (22)	16 (20)	23 (18)	23 (18)	24 (19)	18 (19)	21 (19)	20 (20)	22 (17)
Nerdy	5 (23)	14 (20)	13 (21)	15 (20)	13 (23)	10 (23)	10 (23)	10 (24)	12 (23)	12 (22)	4 (24)	18 (20)
Boring	4 (24)	12 (22)	7 (23)	16 (19)	6 (24)	10 (23)	10 (23)	11 (22)	9 (25)	10 (23)	4 (24)	15 (21)
Sits at a desk	2 (25)	6 (25)	5 (25)	7 (25)	4 (25)	3 (25)	1 (25)	5 (25)	12 (23)	5 (25)	7 (23)	4 (25)

NOTE: Pairs of shaded cells indicate responses where differences exceeded the sampling tolerance and are therefore significant. Gray = adults vs. all teens. Black = boys vs. girls.

TABLE 3-7 Examples of Engineering Considered "Very Appealing," by Percentage (rank)

	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
Example		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Machines that allow blind people to see	60 (1)	48 (2)	50 (3)	47 (3)	62 (1)	50 (1)	43 (9)	48 (2)	57 (2)	56 (2)	61 (2)	51 (2)
Building cars that run on alternative fuels	58 (2)	51 (1)	54 (2)	48 (2)	55 (3)	48 (2)	47 (6)	33 (13)	61 (1)	61 (1)	64 (1)	57 (1)
Protecting the water supply	54 (3)	37 (7)	36 (10)	39 (5)	46 (8)	29 (17)	23 (21)	22 (23)	50 (7)	46 (8)	48 (10)	44 (6)
Wind power	48 (4)	29 (18)	31 (21)	27 (16)	40 (12)	21 (23)	21 (22)	52 (1)	46 (11)	33 (17)	35 (19)	31 (14)
Creating more advanced MRI	47 (5)	32 (14)	29 (23)	35 (9)	54 (4)	48 (2)	43 (9)	31 (15)	54 (4)	48 (4)	49 (9)	48 (3)
Protecting rainforest by developing new ways to farm	47 (5)	40 (5)	35 (11)	45 (4)	40 (12)	26 (20)	19 (24)	35 (11)	49 (7)	42 (12)	44 (16)	40 (10)
Solar energy	47 (5)	35 (7)	35 (11)	35 (9)	47 (6)	36 (12)	37 (12)	46 (4)	56 (3)	45 (10)	52 (7)	38 (12)
Making cars safer	43 (8)	31 (15)	32 (20)	31 (13)	57 (2)	47 (5)	49 (5)	43 (5)	52 (5)	48 (4)	53 (6)	44 (6)
Using DNA to solve crimes	42 (9)	43 (4)	34 (15)	50 (1)	47 (6)	35 (13)	27 (14)	27 (18)	42 (12)	44 (11)	45 (15)	43 (8)

Space exploration	40 (10)	45 (3)	55 (1)	35 (9)	35 (20)	27 (18)	27 (14)	47 (3)	39 (14)	46 (8)	50 (8)	43 (8)
Making homes safer	40 (10)	27 (22)	24 (25)	29 (14)	52 (5)	44 (7)	40 (11)	42 (6)	49 (7)	38 (14)	41 (17)	36 (13)
Reducing air pollution	40 (10)	33 (13)	26 (24)	38 (6)	39 (14)	47 (5)	52 (4)	27 (18)	52 (5)	47 (6)	46 (12)	47 (5)
Smart traffic solutions	38 (13)	28 (20)	35 (11)	21 (19)	44 (10)	27 (18)	26 (16)	31 (15)	42 (12)	33 (17)	36 (18)	29 (16)
Missile defense systems	37 (14)	30 (17)	44 (5)	19 (23)	37 (17)	31 (14)	31 (13)	15 (23)	35 (16)	33 (17)	48 (10)	20 (25)
Turning deserts into farmland	37 (14)	25 (23)	33 (17)	17 (24)	39 (14)	15 (26)	15 (25)	36 (10)	34 (18)	29 (23)	32 (23)	26 (20)
DNA Test	34 (16)	34 (10)	33 (17)	36 (7)	31 (23)	31 (14)	24 (20)	39 (8)	35 (16)	29 (23)	34 (21)	24 (23)
Designing world's fastest plane	34 (16)	31 (15)	44 (5)	20 (22)	38 (16)	42 (9)	46 (7)	37 (9)	39 (14)	38 (14)	46 (12)	30 (15)
Making smaller, faster computer processor	34 (16)	34 (10)	44 (5)	26 (17)	44 (10)	48 (2)	60 (1)	35 (11)	49 (7)	47 (6)	56 (3)	39 (11)
Growing organs for transplant	32 (19)	35 (7)	37 (9)	33 (12)	32 (22)	30 (16)	25 (17)	26 (20)	32 (20)	31 (21)	32 (23)	29 (16)

continued

TABLE 3-7 Continued

Example	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Building an acoustically perfect concert hall	27 (20)	29 (18)	34 (15)	24 (18)	37 (17)	26 (20)	25 (17)	25 (22)	27 (22)	31 (21)	34 (21)	28 (18)
Building the world's longest bridge	26 (21)	25 (23)	35 (11)	16 (25)	46 (8)	25 (22)	25 (17)	26 (20)	32 (20)	32 (20)	35 (19)	28 (18)
Developing new foods	24 (22)	25 (23)	31 (21)	21 (19)	23 (26)	19 (24)	11 (26)	32 (14)	23 (25)	21 (25)	23 (26)	19 (25)
HDTV	20 (23)	28 (20)	38 (8)	21 (19)	36 (19)	42 (9)	53 (3)	29 (17)	34 (18)	35 (16)	46 (12)	26 (20)
Designing video games	19 (24)	38 (6)	50 (3)	29 (14)	34 (21)	41 (11)	54 (2)	16 (25)	25 (24)	40 (13)	56 (3)	25 (22)
Developing new fabrics	13 (25)	13 (26)	9 (26)	16 (25)	25 (25)	18 (25)	21 (22)	41(7)	23 (25)	16 (26)	25 (25)	9 (26)
iPod	13 (25)	34 (10)	33 (17)	36 (7)	27 (24)	43 (8)	44 (8)	9 (26)	27 (22)	51 (3)	55 (5)	48 (3)
Velcro	11 (27)	12 (27)	9 (26)	14 (27)	16 (27)	7 (27)	6 (27)	9 (26)	16 (27)	13 (27)	18 (27)	7 (27)

NOTE: Pairs of shaded cells indicate responses where differences exceeded the sampling tolerance and are therefore significant. Gray = adults vs. all teens. Black = boys vs. girls.

BOX 3-2
Messages Tested in the Online Survey

Engineers make a world of difference.*
From new farming equipment and safer drinking water to electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways.

Engineers are creative problem-solvers.
They have a vision for how something should work and are dedicated to making it better, faster, or more efficient.

Engineers help shape the future.
They use the latest science, tools, and technology to bring ideas to life.

Engineering is essential to our health, happiness, and safety.
From the grandest skyscrapers to microscopic medical devices, it is impossible to imagine life without engineering.

Engineers connect science to the real world.
They collaborate with scientists and other specialists (such as animators, architects, or chemists) to turn bold new ideas into reality.

*This message was inspired by a similar theme used to promote National Engineers Week.

Three survey questions addressed responses to the messages. The first asked respondents how appealing the messages were and, separately, how believable and personally relevant they were (how much they cared about the message). Although the committee members were most concerned about the appeal of the messages, they recognized that an appealing message might not be believable, or vice versa. In some cases, a message might be believable but not considered relevant. In other cases, a very appealing message is likely to be considered personally relevant. By triangulating among appeal, believability, and

relevance, the committee hoped to get an accurate sense of the validity of the appeal ratings.

All five tested messages were rated at least "somewhat appealing" by an overwhelming majority of adults and teens, a finding that reinforces the validity of the underlying positioning statement. The message with the highest "very appealing" rating—the most favorable category—among all adults and teens was "Engineers make a world of difference" (Figures 3-1 and 3-2). This message was also considered the

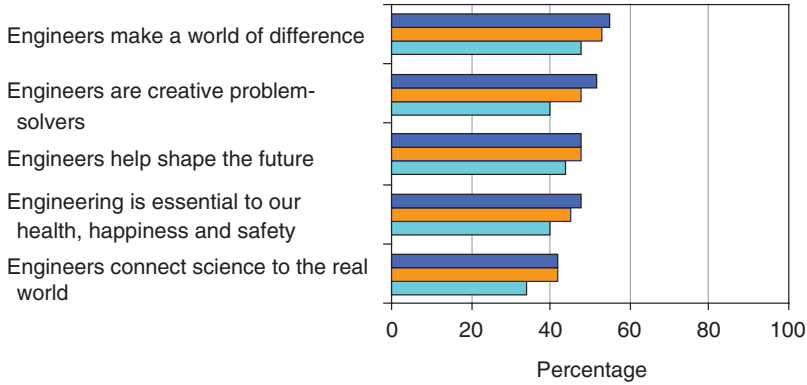

FIGURE 3-1 Messages selected as "very appealing" by adults, by percentage.
Note: Top bar = initial sample. Middle bar = African American oversample. Bottom bar = Hispanic oversample.

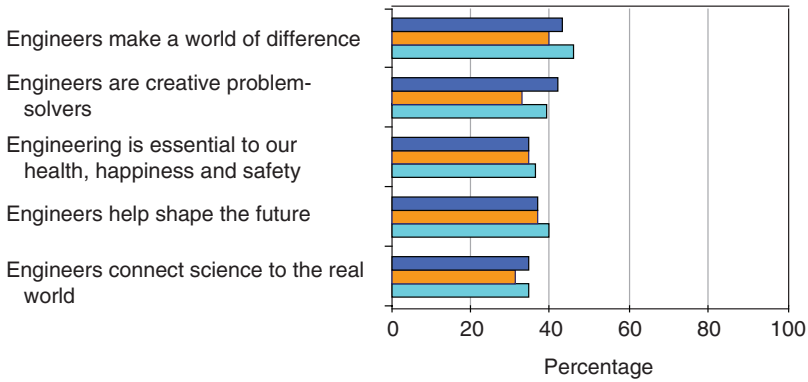

FIGURE 3-2 Messages selected as "very appealing" by teens, by percentage.
Note: Top bar = initial sample. Middle bar = African American oversample. Bottom bar = Hispanic oversample.

most believable and most relevant in most groups (Table 3-8). However, once again, girls were generally less enthusiastic than boys about all of the messages.

The message that received the lowest percentage of "very appealing" rankings by respondents in all groups was "Engineers connect science to the real world." This message was also the least personally

TABLE 3-8 Message Appeal, Believability, and Relevance Among Adults and Teens, by Percentages (rank)

	Initial Sample		African American Oversample		Hispanic Oversample	
Message	Adults	Teens	Adults	Teens	Adults	Teens
Engineers make a world of difference						
Very appealing	55 (1)	43 (1)	53 (1)	40 (1)	48 (1)	46 (1)
Very believable	57 (2)	54 (1)	57 (1)	40 (3)	49 (1)	47 (1)
Care very much	41 (1)	31 (1)	46 (1)	32 (2)	39 (1)	37 (1)
Engineers are creative problem-solvers						
Very appealing	52 (2)	42 (2)	48 (2)	33 (4)	40 (3)	39 (3)
Very believable	58 (1)	53 (2)	54 (2)	39 (4)	44 (4)	44 (3)
Care very much	32 (4)	26 (3)	38 (5)	27 (4)	33 (4)	30 (4)
Engineers help shape the future						
Very appealing	48 (3)	37 (3)	48 (2)	37 (2)	44 (2)	40 (2)
Very believable	56 (4)	48 (4)	53 (3)	46 (1)	45 (3)	46 (2)
Care very much	33 (3)	25 (4)	41 (2)	31 (3)	34 (3)	31 (2)
Engineering is essential to our health, happiness, and safety						
Very appealing	48 (3)	35 (4)	45 (4)	35 (3)	40 (3)	36 (4)
Very believable	57 (2)	50 (3)	49 (4)	35 (5)	47 (2)	39 (4)
Care very much	38 (2)	31 (1)	40 (3)	33 (1)	35 (2)	31 (2)
Engineering connects science to the real world						
Very appealing	42 (5)	35 (4)	42 (5)	31 (5)	34 (5)	35 (5)
Very believable	49 (5)	46 (5)	49 (4)	41 (2)	38 (5)	39 (4)
Care very much	28 (5)	21(5)	39 (4)	23 (5)	29 (5)	27 (5)

NOTE: Pairs of shaded cells indicate responses where differences between adults and teens exceeded the sampling tolerance and are therefore significant.

relevant to all but African American adults. The lack of resonance with this message was confirmed when survey participants were asked to choose the single "most appealing" message of the five (Figures 3-3 and 3-4).

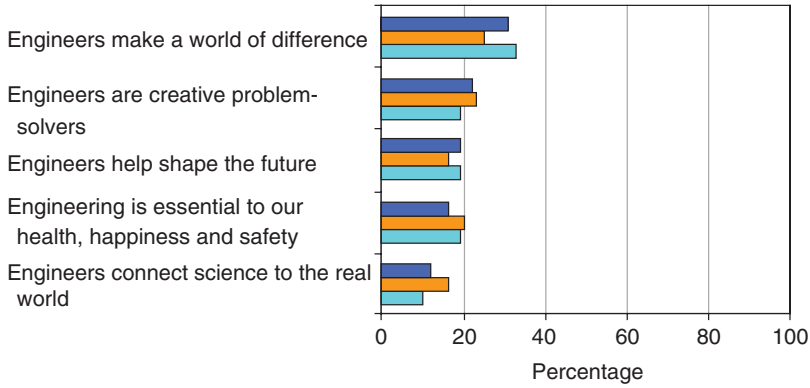

FIGURE 3-3 Messages selected as "most appealing" by adults, by percentage.
Note: Top bar = initial sample. Middle bar = African American oversample. Bottom bar = Hispanic oversample.

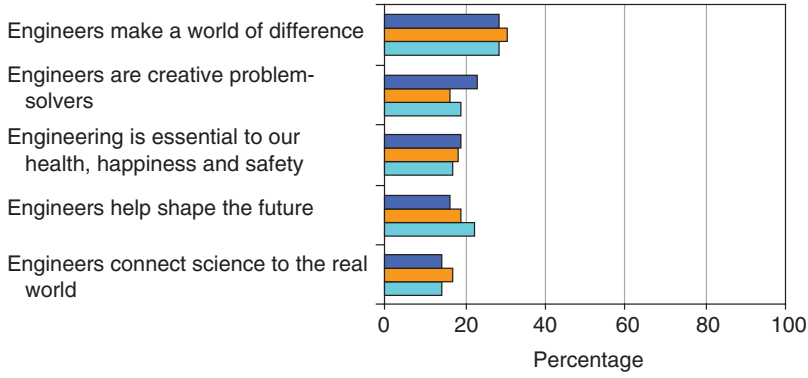

FIGURE 3-4 Messages selected as "most appealing" by teens, by percentage.
Note: Top bar = initial sample. Middle bar = African American oversample. Bottom bar = Hispanic oversample.

Boys in the initial sample found "Engineering makes a world of difference" and "Engineers are creative problem solvers" equally appealing (Table 3-9). This second message did not appeal nearly as much to girls. The second most appealing message for girls, across the board, was "Engineering is essential to our health, happiness, and safety." Girls age 16 and 17 in the African American oversample and all girls in the Hispanic oversample found the "essential to health and happiness" message significantly more appealing than did the boys in those groups. Informed adults in the Hispanic and African American oversamples were significantly more positive than their not informed counterparts about all but one message: Engineers are creative problem-solvers.

As a check on both adult and teen preferences, respondents were also asked to choose a single "least appealing" message (Tables 3-10 and 3-11). "Engineers connect science to the real world" was the least

TABLE 3-9 "Most Appealing" Message, Teens by Gender and Percentage (rank)

	Initial Sample		African American Oversample		Hispanic Oversample	
Message	Boys	Girls	Boys	Girls	Boys	Girls
Engineers make a world of difference	27 (2)	30 (1)	28 (1)	32 (1)	30 (1)	26 (1)
Engineers help shape the future	16 (3)	16 (4)	20 (2)	18 (3)	26 (2)	19 (3)
Engineers are creative problem-solvers	28 (1)	19 (3)	18 (4)	14 (4)	20 (3)	18 (4)
Engineering is essential to our health, happiness and safety	16 (3)	22 (2)	14 (5)	22 (2)	12 (4)	21 (2)
Engineers connect science to the real world	13 (5)	13 (5)	20 (2)	14 (4)	12 (4)	16 (5)

NOTE: Pairs of shaded cells indicate responses where differences between boys and girls exceeded the sampling tolerance and are therefore significant.

TABLE 3-10 "Least Appealing" Message, Teens by Gender and Percentage (rank)

Message	Initial Sample		African American Oversample		Hispanic Oversample	
	Boys	Girls	Boys	Girls	Boys	Girls
Engineers make a world of difference	17 (3)	13 (5)	10 (5)	14 (5)	10 (5)	13 (5)
Engineers help shape the future	16 (5)	24 (2)	21 (2)	24 (1)	24 (2)	27 (1)
Engineers are creative problem-solvers	21 (2)	16 (4)	18 (4)	20 (3)	12 (4)	17 (4)
Engineers connect science to the real world	29 (1)	25 (1)	21 (2)	24 (1)	30 (1)	20 (3)
Engineering is essential to our health, happiness and safety	17 (3)	24 (2)	30 (1)	19 (4)	23 (3)	23 (2)

NOTE: Pairs of shaded cells indicate responses where differences between boys and girls exceeded the sampling tolerance and are therefore significant.

appealing message for all but African American boys, who found the message "Engineering is essential to our health, happiness, and safety" least appealing, and Hispanic girls, who found the message "Engineers help shape the future" least appealing. Among Hispanic adults, women reacted more positively to "Engineers are creative problem solvers" than men.

Preliminary Testing of Taglines

Several preliminary taglines (Box 3-3) were tested, although, because of time and funding constraints, the taglines were developed quickly without creative prototypes (such as posters, TV ads, or web pages) or input from focus groups. Thus the survey results do not represent the best measure of the potential (or lack of potential) of

TABLE 3-11 "Least Appealing" Message, Adults by Gender and Percentage (rank)

	Initial Sample		African American Oversample		Hispanic Oversample	
Message	Men	Women	Men	Women	Men	Women
Engineers make a world of difference	11 (5)	13 (5)	12 (5)	8 (5)	13 (5)	10 (5)
Engineers help shape the future	16 (4)	19 (2)	20 (3)	24 (3)	20 (3)	20 (3)
Engineers are creative problem-solvers	22 (3)	17 (3)	24 (2)	16 (4)	14 (4)	23 (2)
Engineers connect science to the real world	25 (1)	34 (1)	25 (1)	26 (1)	28 (1)	26 (1)
Engineering is essential to our health, happiness and safety	25 (1)	16 (4)	19 (4)	25 (2)	26 (2)	20 (3)

NOTE: Pairs of shaded cells indicate responses where differences between boys and girls exceeded the sampling tolerance and are therefore significant.

BOX 3-3
Preliminary Taglines

- Turning ideas into reality
- Because dreams need doing
- Designed to work wonders
- Life takes engineering
- The power to do
- Bolder by design
- Behind the next big thing

these taglines. Nevertheless, it was encouraging that several of them tested well.

"Turning ideas into reality" tested well among all survey respondents (Figures 3-5 and 3-6). This straightforward tagline, which is consistent with the messaging used by National Engineers Week, is more descriptive than evocative. It states plainly that engineers translate creative thinking into practical solutions. Perhaps that is one reason it scored well as a tagline. By itself, without any additional creative context, it makes the most sense.

It is interesting to note, however, that "Turning ideas into reality" was part of the key message, "Engineers connect science to the real world," which was the least appealing of the five tested messages, especially among women. This discrepancy reinforces the need for qualitative testing of taglines.

The second most appealing tagline varied among the sample populations. African American teens, for example, favored, "Designed to work wonders." The second favorite choice of adults and teens in the initial sample and the Hispanic oversample was "Because dreams need doing." The similar responses of girls and boys in all three populations to this tagline (Table 3-12) suggests that "Because dreams need doing" may be relatively gender neutral. Among Hispanic teens, there were significant gender differences for three of the seven taglines. Among African American teens, girls ages 16–17 were significantly more likely than all African American boys (44 vs. 29%) to find "Turning ideas into reality" very appealing.

CONCLUSION

The qualitative and quantitative research for this study provided useful data on the perceptions of engineering and engineers held by adults and teens and focused attention on the particular messages that resonated most with the sample groups. The research process itself was educational for the committee, not only because it shed light on public understanding of engineering, but also because it provided insights into the benefits and limitations of market research. Key findings from all of the research for this study are summarized in the annex to this chapter.

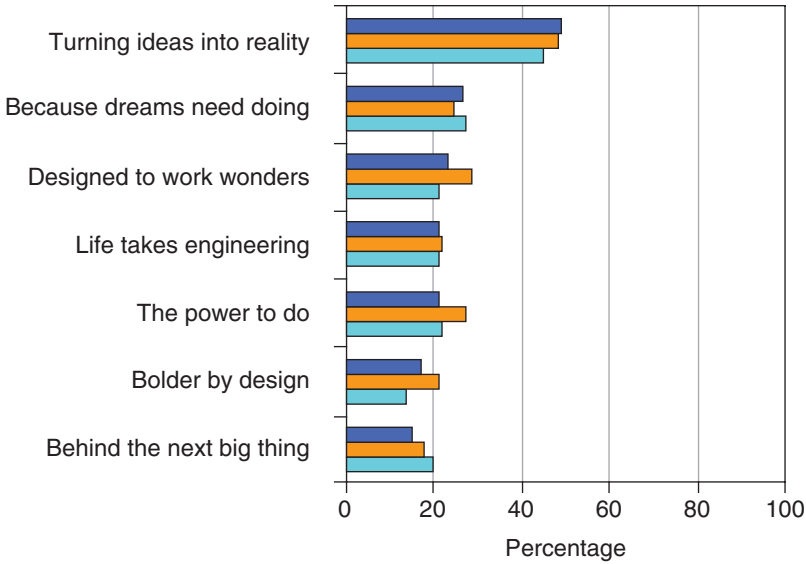

FIGURE 3-5 Preliminary taglines selected as "very appealing" by adults, by percentage. Note: Top bar = initial sample. Middle bar = African American oversample. Bottom bar = Hispanic oversample.

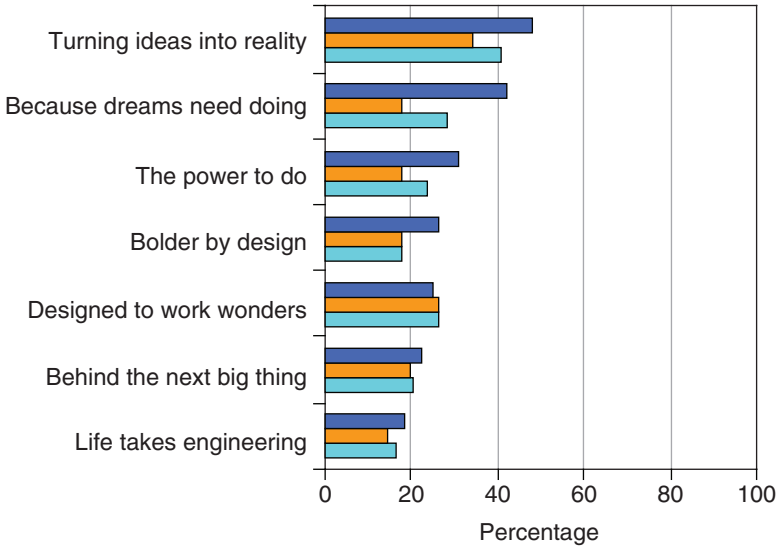

FIGURE 3-6 Preliminary taglines selected as "very appealing" by teens, by percentage. Note: Top bar = initial sample. Middle bar = African American oversample. Bottom bar = Hispanic oversample.

TABLE 3-12 Preliminary Taglines Selected as "Very Appealing" by Adults, Teens, and Teens by Gender, by Percentage (rank)

	Initial Sample				African American Oversample				Hispanic Oversample			
	Adults	Teens			Adults	Teens			Adults	Teens		
Tagline		All	Boys	Girls		All	Boys	Girls		All	Boys	Girls
Turning ideas into reality	46 (1)	48 (1)	54 (1)	43 (1)	48 (1)	34 (1)	29 (1)	38 (1)	45 (1)	41 (1)	47 (1)	35 (1)
Because dreams need doing	24 (2)	42 (2)	43 (2)	42 (2)	24 (4)	18 (4)	17 (6)	18 (4)	27 (2)	28 (2)	28 (3)	28 (2)
The power to do	20(3)	31 (3)	37 (3)	25 (3)	27 (3)	18 (4)	21 (4)	16 (6)	22 (3)	24 (4)	28 (3)	20 (4)
Bolder by design	18 (6)	26 (4)	33 (4)	20 (6)	21 (6)	18 (4)	16 (7)	19 (3)	14 (7)	18 (6)	22 (6)	15 (5)
Designed to work wonders	20 (3)	25 (5)	29 (5)	21 (4)	28 (2)	26 (2)	26 (2)	25 (2)	21 (4)	26 (3)	32 (2)	21 (3)
Behind the next big thing	14 (7)	23 (6)	26 (6)	21 (4)	18 (7)	20 (3)	23 (3)	17 (5)	20 (6)	21 (5)	27 (5)	15 (5)
Life takes engineering	20 (3)	19 (7)	24 (7)	15 (7)	22 (5)	15 (7)	20 (5)	12 (7)	21 (4)	17 (7)	19 (7)	14 (7)

NOTE: Pairs of shaded cells indicate responses where differences exceeded the sampling tolerance and are therefore significant. Gray = adults vs. all teens. Black = boys vs. girls.

One of the most important outcomes of the research was to demonstrate how much perceptions of mathematics and science have shaped perceptions of engineering. Evidently, messages from the engineering community linking success in engineering to skills in mathematics and science have reached a wide audience. Although this message is correct, our research suggests that it has not been effective in improving the appeal of engineering.

The committee received more public comments on the linkage of science and mathematics to engineering than on any other subject. Several people suggested that attracting more students to engineering will ultimately require improving the teaching of math and science, including how applications of math and science are relevant to students.

Another result of our research was to demonstrate that age and gender affect perceptions of engineering and engineers. The differences were most evident in the online survey. For example, adults, who have much more experience in the world of work than teens, were generally more concerned about job availability. One implication of this difference for messaging is to keep in mind that adults, who may influence students' career choices, may be especially sensitive to reports (accurate or not) of the outsourcing of technical jobs, including engineering jobs, and the resultant possible decrease in employment opportunities.

The research strongly suggests that boys and girls have different reactions to messages and different perceptions of engineering. The focus groups and triads confirmed other research showing that girls are much more comfortable with images of engineering that include people, especially women, whereas boys tend to gravitate to "things." This suggests messaging that targets girls should include a human element.

Boys also appear to have a more positive outlook toward engineering as a career choice than girls, who are less confident that engineering can be a rewarding profession that will have a positive effect on people's lives. This relatively negative view of engineering has been documented in other research (EWEP, 2005; EWEP, unpublished). Girls also were generally less responsive to all of the messages tested in this project.

The research also exposed a "disconnect" between the engineering community's self-perception and the public perception of

engineers. The image of a nerdy, dull person, as popularized in the comic strip *Dilbert*, is widely accepted as a given by the engineering community. However, our research shows Dilbert is not the public's image of an engineer. Neither adults nor teens in our study correlated Dilbert's characteristics with real engineers. This means that messaging resources that might have been invested in efforts to counter the "nerdiness" image can be spent in more productive ways.

Finally, the research shows there are few significant ethnicity-based differences in the way adults and teens perceive engineers, engineering, and messages and taglines meant to improve the image of engineering. This does not mean, however, that messaging efforts, particularly the use of taglines, should not take ethnicity, culture, language, and other factors into account. For optimum effectiveness, messaging needs to be contextualized for the target population.

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ANNEX
SUMMARY OF KEY RESEARCH FINDINGS

This annex consolidates the most important research findings from this project. By putting all of the information in one place, the committee hopes to help readers identify results most relevant to their needs. Since no two outreach efforts are likely to use identical tactics or share the same purpose or target audience, certain findings will be more significant for some readers than for others. The committee organized the annex to reflect the very important idea of audience segmentation. Thus, findings that call out differences in attitudes or understanding between teens and adults are grouped together, as are findings for boys and girls, men and women, and informed and not informed adults. When used in concert with the detailed data presented in the body of Chapter 3, the annex should be a useful guide for designing effective outreach to improve public understanding of engineering.

FOCUS GROUPS AND TRIADS

Students

The majority of students understand that engineers "design and build things" but tend to have a very limited idea of what engineers actually do.

Students do not have an overtly negative impression of engineers, but many feel that they are not smart enough or do not enjoy math or science enough to become engineers themselves.

Many students think that engineers are sedentary, work mostly on computers, and have little contact with other people.

Most girls believe that women have the talent and intellect to become engineers, if they so choose.

When asked to name engineers they knew or had heard of, including those who had come to their schools on career days, most students could name only men.

Examples of engineering related to the objects and activities of students' daily lives aroused a great deal of interest.

"Making good money" was the career goal mentioned most often by students.[3] The idea of "helping make a difference" also had a very strong appeal.

Parents

Parents were mostly of the opinion that engineering would provide their child with job security in the form of good salary and benefits, as well as a career path that would enable them to continue to grow and succeed.

Parents tended to prefer the more practical messages, underscoring their concerns about job security for their children.

ONLINE SURVEY

General Findings

Both adults and teens said the most distinguishing characteristic of engineers is their high skill level in mathematics and science.

Less than 15 percent of adults or teens described engineers as "boring" or "nerdy."

Technologies that have yet to be developed or are not in widespread commercial use were more appealing to adults and teens than technologies already in use.

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[3]This contrasted to the answers from teens in the online survey who rated the importance of salary to job choice second or third behind "interesting work" and "work that makes a difference, is meaningful."

"Engineers make a world of difference" was the message with the highest "very appealing" rating among all adult and teen groups.

"Engineers connect science to the real world" was the least appealing message among all survey groups and the least personally relevant for all but African American adults.

All teens rated interesting work as the most important consideration in choosing a career. Making a difference was second most important among teens in the initial sample and Hispanic teens, and equally important to job availability for African American teens.

Adults in the initial sample and Hispanic oversample rated interesting work and job availability as most important and of equal value in career choice. African American adults rated job availability most important and interesting work second.

Teens versus Adults

Teens in the initial sample were three times as likely as adults to consider engineering "boring" and twice as likely to consider engineers "nerdy."

More teens than adults considered engineers hard workers.

Teens across the board responded more strongly than adults to entertainment technologies, such as iPods and video games.

Informed versus "Not Informed" Adults

Adults in the initial sample classified as "not informed" were more than twice as likely as informed adults to believe salary was extremely important to career choice.

Informed adults in all three samples were significantly more likely than the not informed cohorts to associate math and science with engineering.

Informed adults in the Hispanic and African American oversamples were significantly more positive than their not informed counterparts about all but one message: Engineers are creative problem-solvers.

Men versus Women

African American women were more likely than African American men to believe engineers are well paid, hard working, and smart.

Men in all three samples asserted greater knowledge of engineering than did women.

Among Hispanic adults, women reacted more positively to "Engineers are creative problem solvers" than men.

Boys versus Girls

In all of the teen groups, boys were nearly twice as likely as girls to rate engineering as a very good career choice.

Boys in all three samples claimed they had greater familiarity with engineering than girls.

African American girls were significantly more likely than African American boys to want a job that "makes a difference."

African American boys were significantly more likely than African American girls to consider salary extremely important to job choice.

Hispanic girls were significantly more likely than Hispanic boys to think engineers were nerdy and boring.

Hispanic girls were significantly less likely than Hispanic boys to believe engineering has a positive effect on people's everyday lives.

In all teen groups, computer processors, video games, and high-definition television were significantly more appealing to boys than to girls.

Girls in the initial sample and African American oversample found the idea of using DNA evidence to solve crimes much more appealing than did boys in these populations.

Girls were generally less enthusiastic than boys about all of the messages.

Boys in the initial sample found "Engineering makes a world of difference" and "Engineers are creative problem solvers" equally appealing messages. The second message did not appeal nearly as much to girls.

After "Engineers make a world of difference," the second most appealing message for girls across the board was "Engineering is essential to our health, happiness and safety."

"Engineers connect science to the real world" was the least appealing message for all teens. However, African American boys disliked the "Engineering is essential to our health, happiness and safety" message most, and Hispanic girls disliked the "Engineers help shape the future" message most.

4 CONCLUSIONS AND RECOMMENDATIONS

The purpose of this project was to look beyond the engineering community and to change the longstanding pattern of self-initiated, ad hoc communications. To make this goal, the committee needed both an independent analysis of the situation and the advice of experienced, creative market-research professionals.

One unanticipated benefit of engaging outside professionals was that committee members were encouraged, indeed obliged, to become educated about the processes, benefits, and limitations of message development and testing. Another was that our many interactions with Bemporad Baranowski Marketing Group/Global Strategy Group led to a relationship of trust and mutual respect that facilitated our dialog about complex, sometimes difficult, issues.

Market research is as much an art as a science. Although it is desirable, and often feasible, to gather data via focus groups and surveys, gathering the right data, and doing it effectively, requires a professional approach based on judgment, experience, and common sense. Market research provided direction and a rationale for helping us allocate time, money, and human resources in developing our positioning statement and messages.

Happily, our research revealed that the public does not have a negative image of engineers. In fact, the public has a much more positive view of engineers than engineers seem to have of themselves. Most adults and teens in our samples respect engineers and believe that their work is both rewarding and important, although they also have a poor idea about what engineers do on a day-to-day basis. They also have a strong sense that engineering is not "for everyone," especially not for girls. The public understanding of engineering is strongly linked to just one aspect of the discipline—the need for mathematics and science skills. Other vital aspects of engineering, such as creativity, teamwork, and communication, are largely unknown.

Based on the results of our research, we can make a strong case that effective messaging will require different messages for different target audiences (see Table 3-10). For example, when branding engineers or marketing engineering to teens, we must take into account how their ideas of engineering and their interests differ from those of adults. In addition, messages for teens will have to be adapted to take into account gender, because girls and boys have different perspectives on engineering and different connections to it.

In the sections that follow, the committee presents conclusions and recommendations that will lead to strategic as well as tactical changes in the way the engineering community communicates with the public. In the first section, the committee addresses how the positioning statement, messages, and taglines should be used. The second section includes an argument for a centralized public relations "tool kit" for the engineering community. In the third section, the committee proposes an ambitious, long-term initiative—the development and implementation of a large-scale communications "campaign."

USING THE POSITIONING STATEMENT, MESSAGES, AND TAGLINES

We live in a society inundated with information and messages. More than 25 years ago, advertising experts Al Ries and Jack Trout lamented, "There's a traffic jam on the turnpikes of the mind" (Ries and Trout, 1981). Since then, the situation has gotten even worse. Publishers

in the United States put out hundreds of thousands of books every year, viewers can choose from hundreds of television channels, and Internet users can instantaneously search billions of web pages via a variety of search engines.

To help break through the communications clutter, the committee recognized that it would be necessary to use modern mass-marketing techniques, which are commonly used in the commercial and political sectors but rarely used by the engineering community for public outreach. Up to now, efforts to promote a positive image of engineering have largely been based on opinions and educated guesses about the kinds of messages that will work. Decisions have been made by leadership and staff of engineering organizations that rarely reflect the makeup of the target populations of these messages (i.e., young people, girls, and underrepresented minorities). Although some individuals may have training in public relations or marketing, as far as the committee could tell, few engineering organizations have relied on the services of professional creative or market-research firms.

One of the most important findings of this study is the strong association in the minds of the public between engineering and competency in mathematics and science. "Must be good at math and science" was by far the most frequently selected attribute of engineers in our online surveys, indicating that messages emphasizing ability in mathematics and science as a prerequisite to the study of engineering have been absorbed by both adults and teenagers. Our testing also showed that the least appealing of five tested messages was the one that portrayed engineers as "connecting science to the real world."

From this, we concluded that, if we continue to overly emphasize math and science in marketing or rebranding engineering, we are likely to alienate or scare off youngsters, rather than attract them to engineering. We believe the same can be said about messages that focus on the practical benefits of being an engineer rather than the inspirational, optimistic aspects of engineering.

Recommendation 1. To present an effective case for the importance of engineering and the value of an engineering education, the engineering community should engage in coordinated, consistent, effective com-

munication to "reposition" engineering. Specifically, the engineering community should adopt and actively promote the positioning statement (Box 4-1) in this report, which emphasizes that engineering and engineers can make a difference in the world, rather than describing engineering in terms of required skills and personal benefits. The statement should not appear verbatim in external communications but should be used as a point of reference, or anchor, for all public outreach.

Of course, mathematics and science will continue to be necessary skills for engineers. Math and science skills can last a lifetime and can also provide a springboard for careers in many fields. At this point, an analogy with the medical profession might be instructive for showing how a change in messaging might work. The medical profession, which depends heavily on science skills, does not market itself to young people by emphasizing that they will have to learn organic chemistry. Physicians are promoted as people who cure disease and relieve human suffering.

In marketing engineering, we too ought to appeal to the hopes and dreams of prospective students and the public. This approach will not only appeal to the higher aspirations of young people, but will also place math and science skills, correctly, as *one* of a variety of skills and

BOX 4-1
A Positioning Statement for Engineering

No profession unleashes the spirit of innovation like engineering. From research to real-world applications, engineers constantly discover how to improve our lives by creating bold new solutions that connect science to life in unexpected, forward-thinking ways. Few professions turn so many ideas into so many realities. Few have such a direct and positive effect on people's everyday lives. We are counting on engineers and their imaginations to help us meet the needs of the 21st century.

dispositions necessary for successful engineers, including collaboration, communication, and teamwork.

In addition to developing a new, powerful positioning statement, we created and tested several messages. Our research does not, and should not, preclude others from pursuing additional message development, but the committee believes that the rigorous process we used to generate our messages justifies their widespread use. In February 2008, the National Academy of Engineering launched a new website, Engineer Your Life (*www.engineeryourlife.org*), which aims to interest academically prepared high school girls in careers in engineering. The site used our message "Engineers make a world of difference" on its homepage and adopted other key words vetted in our research, such as creativity and problem-solving.

Recommendation 2. The four messages that tested well in this project—"Engineers make a world of difference," "Engineers are creative problem-solvers," "Engineers help shape the future," and "Engineering is essential to our health, happiness, and safety"—should be adopted by the engineering community in ongoing and new public outreach initiatives. The choice of a specific message should be based on the demographics of the target audience(s) and informed by the qualitative and quantitative data collected during this project.

Finally, the committee notes that, because of money and time constraints, we were not able to carry out a full creative process in the development of taglines, which would have led to many more possible taglines, presentations of the taglines in context, and testing of the contextualized taglines in focus groups. Nevertheless, the positive responses via online testing to several of the taglines suggest that they may be able to be effectively used for engineering-outreach projects. The committee believes the taglines should be further tested to identify and validate which ones might be appropriate for a broad-scale national campaign.

Recommendation 3. More rigorous research should go forward to identify and test a small number of taglines for a nationwide engineer-

ing-awareness campaign. The taglines should be consistent with the positioning statement and messages developed through this project and should take into account differences among target populations. In the interest of encouraging coordination among outreach activities, the results of this research should be made widely available to the engineering community.

CREATING A SHARED PUBLIC-RELATIONS RESOURCE

Engineering societies, universities, technology-based firms, federal laboratories, museums, and other organizations currently spend more than $400 million annually to promote public awareness of engineering (Davis and Gibbin, 2002). These ad hoc efforts, although praiseworthy in their intentions, have not succeeded, largely because their messages are not consistent. In addition, because of the discontinuous nature of these efforts, it has been impossible to develop effective metrics to measure their effectiveness and refine the messages accordingly. The committee concludes that, in the short term, consistent messages, even by a modest number of these organizations, could be a huge step forward in promoting a positive, appealing image of engineering.

Recommendation 4. To facilitate deployment of effective messages, an online public relations "tool kit" should be developed for the engineering community that includes information about research-based message-development initiatives and examples of how messages have and can be used effectively (e.g., in advertising, press releases, informational brochures, and materials for establishing institutional identity). The online site should also provide a forum for the sharing of information among organizations.

LAUNCHING A CAMPAIGN

Although making current messages more consistent is an important short-term goal, the committee concludes that a more explicit, coordinated approach is likely to yield better results in the long term. Thoughtful targeting of the messages and further refinement of the taglines for public outreach about engineering will be necessary, but

not sufficient. Outreach efforts must be embedded in a larger strategic framework—a communications campaign driven by a strong brand positioning statement and involving a variety of communication methods. A campaign must include diverse messengers and be supported by dedicated resources. Finally, the campaign must include metrics for determining the effectiveness of its components and, equally important, must be given enough time to succeed.

In short, a campaign must reach multiple audiences in creative ways, using the following tools and techniques:

- traditional and online advertising;
- corporate partnerships/sponsorships;
- pop-culture initiatives (e.g., contests, games, books, TV specials, documentary projects);
- educational initiatives (e.g., curricula);
- outreach to young people, parents, educators, guidance counselors, and the media; and
- media training for ambassadors or spokespersons.

A campaign of the size and duration that will have a measurable impact on the public understanding of engineering will require significant resources. Our consultants proposed a "conservative" price tag of $12 million to $25 million per year for two or three years. This may be enough to launch a campaign, but the long-term costs could easily be higher. The recent "Got Milk?" campaign targeting teenagers cost $20 million annually (Levere, 2006), and the Centers for Disease Control and Prevention anti-obesity campaign, "Verb: It's What You Do," targeting young people ages 9 to 13, had a budget of $59 million in 2005 (Beirne, 2006).

Resources of this magnitude are not likely to be forthcoming from government or foundations. Thus the question arises as to whether the engineering community, particularly large and influential technology-focused corporations, will be willing to support such an initiative.

A second concern is how the campaign would be organized and carried out. Some degree of centralized planning will be necessary to ensure coordination and communication, which will require agree-

ment by the major participants. There is already one cooperative outreach venture in engineering, National Engineers Week, which might be leveraged for this purpose. We might, however, need a new structure to coordinate a campaign.

A final concern relates to the need for metrics to determine the effectiveness of messages and projects. Although measuring the outcomes of public outreach efforts is notoriously difficult, a campaign of this scope must include a substantial evaluation component to ensure that we can determine what works and improve upon elements that are not as effective as anticipated.

Recommendation 5. A representative cross section of the engineering community should convene to consider funding, logistics, and other aspects of a coordinated, multiyear communications campaign to improve the public understanding of engineering.

A FINAL WORD

The project described in this report was conducted according to a carefully designed process for developing messages to improve the public understanding of engineering. The approach included the services of professionals in the fields of communications and market research and required both quantitative and qualitative research methods. To ensure balance and accuracy, the report and the findings and recommendations were carefully vetted by outside experts, whose comments and suggestions led to improvements in the final document. The rigor of the study process should reassure the engineering community—and others interested in this important topic—that a tested set of tools is now available to promote a more positive image of engineering and engineers.

As suggested in Recommendation 4, we know that more work will be necessary to enrich, expand, and disseminate messaging resources, and, as noted in Recommendation 3, more research on taglines will be necessary. Neither of these requirements, however, should delay or discourage action by the engineering community. Even if the national campaign described in Recommendation 5 is not immediately forth-

coming, creative implementation of messages and taglines can have an immediate impact. Combined efforts by multiple organizations following the same "playbook" can create positive momentum toward increasing the appeal of engineering to students, educators, parents, policy makers, and society at large.

The most significant outcome of this project is the recasting of engineering as articulated in the positioning statement. If this statement were adopted by the engineering community, as urged in Recommendation 1, we can not only reshape the self-images of engineers, but also empower engineers to communicate more confidently with the public. In this way, we may truly change the conversation.

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VIRGIL R. CARTER is executive director of the American Society of Mechanical Engineers (ASME), where his responsibilities include overseeing budgets, staff, and technical and educational activities, as well as management of the ASME Foundation and affiliated business entities. His professional career spans 42 years and includes military service, executive and ownership positions in business, academic teaching and administration, and association management. After earning a Bachelor of Architecture degree from Oklahoma State University (OSU) in 1964, he served as a captain on a Special Forces A-Team in Vietnam. After the war, he earned a master's degree in architecture from the University of Illinois in 1969. In 1986, after 17 years of private architectural practice, he returned to OSU as head of the School of Architecture. From 1990

to 1996, Mr. Carter was senior executive at the American Institute of Architects, Washington, D.C., and in 1996 he founded Business & Educational Advisory Services, in Falls Church, Virginia. In 1997, be became executive director of the Project Management Institute, which experienced a 350 percent net growth in membership and expanded its global membership to 120 countries under his leadership. In 2002, he accepted his current position at ASME. Mr. Carter travels frequently throughout the world in support of ASME, engineering, and technology. He is a fellow of the American Institute of Architects and a member of several other organizations, including the American Society of Association Executives, the Pennsylvania Art Association, and the Special Forces Association.

WILLIAM S. HAMMACK, a professor of chemical and biomolecular engineering at the University of Illinois, Urbana-Champaign, earned a B.S. in chemical engineering from Michigan Technological University and an M.S. and Ph.D. from the University of Illinois. He taught for 10 years at Carnegie Mellon University before returning to Illinois, where he worked on outreach to the public to explain engineering and technology. He has created more than 300 pieces for pubic radio, which have been heard on "Marketplace" and around the world on Radio National Australia, for which he received the American Institute of Chemical Engineers Service to Society Award, the American Society of Mechanical Engineer's Edwin F. Church Medal, the American Society of Engineering Education's President's Award, the IEEE Award for Distinguished Literacy Contributions, the American Chemical Society's Grady-Stack Award, and the American Institute of Physics Science Writing Award. In addition, he teaches a General Education course on engineering for non-majors. He spent 2005–2006 on leave from the university as a Jefferson Science Fellow at the U.S. Department of State.

LEAH H. JAMIESON (NAE) is John A. Edwardson Dean of Engineering and Ransburg Distinguished Professor of Electrical and Computer Engineering, Purdue University; she also has a courtesy appointment in Purdue's Department of Engineering Education. Dr. Jamieson has been

recognized for her achievements as co-founder (with Edward J. Coyle) and co-director (with William C. Oakes) of the Engineering Projects in Community Service (EPICS) Program, which was awarded the National Academy of Engineering's 2005 Bernard M. Gordon Prize for Innovation in Engineering and Technology Education. Also for EPICS-related activities, she (and Coyle) received the 1997 Chester F. Carlson Award for Innovation in Engineering Education from the American Society for Engineering Education, and Dean Jamieson received the IEEE Education Society 2000 Harriet B. Rigas "Outstanding Woman Engineering Educator" Award. Dr. Jamieson was one of the inaugural recipients of the NSF Director's Award for Distinguished Teaching Scholars (2001), was inducted into Purdue's Book of Great Teachers (2003), and was named 2002 Indiana Professor of the Year by the Carnegie Foundation and the Council for the Advancement and Support of Education. Dr. Jamieson has conducted research on speech analysis and recognition and the design of parallel processing algorithms and software for digital speech, image, and signal processing, and is the author of more than 175 papers and co-editor of *Algorithmically Specialized Parallel Computers* (Academic Press, 1985) and *The Characteristics of Parallel Algorithms* (MIT Press, 1987). She is 2007 president and CEO of IEEE and has held many other leadership positions at IEEE since 1998. She has also been associate editor and a member of the editorial board for several IEEE publications, a member of the Advisory Committee for the NSF Directorate for Computer and Information Science and Engineering (1998–2000), and a member (1998–2001, 2001–2004, 2005–2007) and secretary (1999–2001) of the Board of Directors of the Computing Research Association. She received her S.B. in mathematics from MIT and Ph.D. from Princeton University.

JAMES H. JOHNSON, JR., is a professor of civil engineering and dean of the College of Engineering, Architecture, and Computer Sciences at Howard University. He received his B.S. from Howard University, his M.S. from the University of Illinois, and his Ph.D. from the University of Delaware. His research interests include the treatment and disposal of hazardous substances, environmental policy in relation to minorities, nanomaterials in environmental restoration, and envi-

ronmental curricula and strategies for increasing the participation of underrepresented groups in science, technology, engineering, and mathematics disciplines. A member of the National Research Council (NRC) Division of Earth and Life Sciences Oversight Committee, Environmental Protection Agency Science Advisory Board, American Society of Civil Engineers (ASCE) Committee on Diversity and Women in Civil Engineering, and vice chair of the Anne Arundel Community College (Maryland) Board of Trustees, he has also served on several university, private-sector, and research-center advisory committees, NRC boards and committees, and government advisory committees. The author of more than 60 scholarly articles, a contributor to three books, and co-editor of two books, Dr. Johnson is a registered professional engineer in the District of Columbia, a diplomate of the American Academy of Environmental Engineers, and the 2005 recipient of the National Society of Black Engineers Lifetime Achievement Award in Academia.

VIRGINIA KRAMER, executive creative director at the advertising and public relations firm Keiler & Co., oversees creative products of all kinds, including print and broadcast advertising, collateral products, direct mail products, and interactive products. Ms. Kramer is an award-winning copywriter with broad experience working with clients in a variety of industries, including financial services, banking, insurance, health care, aerospace, high technology, medical devices, pharmaceuticals, manufacturing, publishing, and the performing arts. Ms. Kramer graduated (magna cum laude) from the University of Hartford. She was a participant in the NAE preliminary focus group in April 2005 on public understanding of engineering messaging.

PATRICK J. NATALE is executive director of the American Society of Civil Engineers (ASCE) and the recipient of the 2006 Kenneth Andrew Roe Award from the American Association of Engineering Societies. Prior to joining ASCE in 2002, Mr. Natale was executive director of the National Society of Professional Engineers (NSPE), where he had been active in leadership and internal management for many years at both national and state levels. In 1997, Mr. Natale received the NSPE

Distinguished Service Award, and in July 2000, he was named a Fellow of the society. He was also president, national director, and practice division officer of the New Jersey Society of Professional Engineers. Mr. Natale had a 28-year career at Public Service Electric and Gas Company of New Jersey, where he held many top-level jobs. Over the years, he was responsible for managing sales, marketing, strategic planning, and customer service; he also led the corporate effort to develop the process and systems for deregulating the energy marketplace in New Jersey. Mr. Natale holds a B.S. in civil engineering from Newark College of Engineering and an M.S. in engineering management from the New Jersey Institute of Technology. He completed the Executive Management Program at Yale University and is a licensed professional engineer in New Jersey and a certified association executive.

DIETRAM A. SCHEUFELE is a professor in the Department of Life Sciences Communication and a member of the steering committee of the Robert F. and Jean E. Holtz Center for Science and Technology Studies at the University of Wisconsin (UW)-Madison. He is also the Wisconsin principle investigator of the National Scence Foundation-funded Center for Nanotechnology in Society, located at Arizona State University, and a member of the Nanotechnology Technical Advisory Group to the President's Council of Advisors on Science and Technology. The focus of Dr. Scheufele's research is shaping public attitudes toward science and technology. He has received the Young Scholar Award for outstanding early research from the International Communication Association, the Young Faculty Teaching Excellence Award from the College of Agriculture and Life Sciences at Cornell University, and the Vilas Associate Award from the University of Wisconsin-Madison. His professional experience includes consulting work for major marketing firms and public-sector clients, including the Public Broadcasting System and the World Health Organization. Prior to joining UW in 2004, he was a tenured associate professor and director of graduate studies in the Department of Communication at Cornell University.

JACQUELYN F. SULLIVAN is founding co-director and director of K-12 Engineering Education for the Integrated Teaching and Learning Program at the University of Colorado (CU) at Boulder, a program that is working toward integrating hands-on engineering throughout the K–16 learning experience. In 2008, Sullivan was co-recipient of the National Academy of Engineering Bernard M. Gordon Prize for Innovation in Engineering and Technology Education, and in 2005 she received the inaugural Lifetime Achievement Award from the K–12 Division of the American Society of Engineering Education. Dr. Sullivan had 13 years of engineering and leadership experience in industry prior to joining CU in 1990, and she was instrumental in founding the university's Integrated Teaching and Learning Program, which provides hands-on engineering experience to more than 4,000 undergraduates annually. She also initiated a K–12 engineering education program for teachers and underserved students and is currently leading a multi-institutional initiative to create an online, searchable, standards-based, digital library of K–12 engineering curricula. She heads a U.S. Department of Education and National Science Foundation-funded project, the TEAMS Program (Tomorrow's Engineering—creAte. iMagine. Succeed.) that incorporates weekly hands-on, inquiry-based engineering into engineering and science classes in grades 3 through 12. Dr. Sullivan is a founding board member of the Denver School of Science and Technology—a public, urban high school that incorporates science, engineering, and technology into a humanities-rich setting focused on student achievement. In addition, she is a long-standing member of (and has chaired) the board of directors of a non-profit community school of the arts. She received her Ph.D. in environmental health physics and aquatic toxicology from Purdue University.

B IN-DEPTH INTERVIEWS: INTERVIEWER'S GUIDE

INTRODUCTION

- Explain the idea of the IDI.
- This is being taped so that I don't have to take notes while you are giving your opinions. . . .
- We just want to hear your opinions. . . . There are no right or wrong answers. Just looking for different perspectives.
- Please speak up when you talk. . . .
- If you have any questions or additional comments, please go right ahead at any time. We have a good deal of material to cover in a short time; feel free to ask questions, but we will need to keep the conversation moving. . . .

ENGINEERING

We're working with the National Academy of Engineering, and today we're going to talk about what people think about engineers in general as well as careers in engineering.

- Please tell me a little about what you do in your job.
  - What is your title?
  - How long have you been in your current position?

- What are the first words or phrases that come to mind when you think about 'engineering'? PROBE: Are there any negative words or phrases that come to mind when you think about engineers or engineering?
  - PROBE: What do you think when a young person says he or she wants to become an engineer?

- What kind of person is an engineer? What traits and characteristics does an engineer have? PROBE FOR EXAMPLES

- Thinking back, what was *your* first memorable experience with engineering? With someone who was an engineer? What was that person like?
  - What got you interested in engineering, if you are interested?

- How do you explain engineering to make it more interesting other people? To children?

- FOR ENGINEERS: What prejudices about engineering do you encounter when you tell people you are an engineer?
  - PROBE: What misconceptions do people have about what you and other engineers do?
  - PROBE: How have perceptions about engineering changed since you first became an engineer? IF CHANGED: What caused those opinions to change?
  - PROBE: Do you think engineering and engineers are taken for granted?

- FOR ENGINEERS: What would you like to change about the public's image of engineers and engineering? How would you change it?

  - What is *right* with engineering?
  - PROBE: What effect does engineering's image have on the long-term health of your profession?

- How do you think engineering is seen as a profession by most people? What image do you think engineering has among school-age children?
  - PROBE: How have perceptions about engineering changed in the last few decades? Have they changed? IF CHANGED: What caused those opinions to change?
  - Where do you see the image of engineering and engineers in ten years? In twenty years? What should it be?
  - What areas of engineering will be more prominent? Chemical, civil, electrical, industrial, manufacturing, mechanical, biochemical? Others? Why? Which will be less prominent? Why?

- Have you seen anything that others have done to promote engineering? PROBE FOR SPECIFICS.

- What do you think *should* be done to promote a more positive image of engineering? What are the specific images or messages about engineering that the field should be emphasizing?
  - What should the field of engineering NOT be promoting? Why not?

- What do you think of others' efforts to cultivate greater public awareness of engineering? PROBE: National Engineers Week? Competitions? Tool kits for teachers and guidance counselors; mentor programs; school-to-work training; cable television shows?
  - PROBE: What do you think has worked? What do you think didn't/doesn't work? How could these efforts be re-directed or made better?
  - PROBE: Are these efforts targeted at the right audiences?

- Why would a child be interested in engineering? What things about engineering do you think could be emphasized to make engineering more appealing to children? To students considering studying engineering at college? To young people considering engineering as a career?
  - What visual images of engineering do you think make engineering more appealing? Which images make engineering less appealing?

- What would you tell a student who asked you about a career in engineering? Where would you send them for more information?
  - What could make a career in engineering more appealing to young people?

- Can you name any engineers who are widely known?
  - PROBE: Who is the face of engineering? Who would be a good spokesperson for engineering?

- What is a good example of engineering at work today? PROBE: What are the success stories that engineering should be telling?
  - Some people say scientists get all the credit for scientific advances, and architects get all the credit for buildings and other projects, but engineers get only the blame when a disaster happens. Do agree that this is the case? Why/why not?

THEMES

- I'd like to ask you about some possible themes that could be used to promote engineering. ROTATE THEMES First…
  - *A LIMITLESS IMAGINATION:* This theme speaks to the innovative, design-driven nature of engineering.

- FOR EACH POSSIBLE THEME, ASK: What do you think of this as a theme to promote engineering?
  - PROBES: What examples should be used to illuminate this theme? What images should be associated with this theme? What examples or images should be avoided?
  - *AN ENTERPRISING SPIRIT*: This theme recognizes the inventive spirit and pioneering contributions of the field.
  - *FREE TO EXPLORE*: This theme evokes the constant journey that is the engineer's quest for new solutions.
  - *IDEAS IN ACTION*: This theme underscores how engineering uniquely bridges the world of science with the real world.
  - PROBE: Is it useful to think of engineers as 'real-world scientists'?
  - *SHAPE THE FUTURE*: This theme speaks to how engineering offers an empowering and rewarding career.
  - *LIFE TAKES ENGINEERING*: This theme focuses on the field's essential role and life-changing work.

- Of the possible themes we discussed, which do you think will be the most effective? Why? Which do you, personally like the best? Why? Which don't you like?

- Can you suggest any other themes like these that could be used to promote engineering? How would it be delivered? At whom would it be targeted? Why?

WRAP UP

- What effect do you think a change in engineering's image would have on the field? How about for you, professionally?

- Finally, if you could give one piece of marketing communications advice to promote engineering, what would it be?

- Is there anything you would like to add that we haven't asked about?

Thank and dismiss.

C FOCUS GROUPS: MODERATOR'S GUIDE—PARENTS

INTRODUCTION **(5 MINUTES)**

- **Moderator introduction:** I represent GSG, an independent opinion-research firm that conducts discussion groups on various topics. We ask people their opinions about everything from hamburgers to cars.

- Explain the idea of the focus group. Go over features of the room, including:
  - One-way mirror—I have colleagues taking notes behind the mirror so that they do not disturb us. . . .
  - Camera/microphones—This is being taped so that I don't have to take notes while you are all giving your opinions. . . . One ground rule: You must talk, and you must talk loud enough so we can all hear you.
  - Completely confidential. Your full names will never be used. We just want to hear your opinions . . . Not a classroom; There are no right or wrong answers.
  - If you have any questions or additional comments, please go right ahead at any time. We have a good deal of material

to cover in a short time; feel free to ask questions, but we will need to keep the conversation moving. . . .

- Group profile: personal background (name, where do you live, how many kids you have and their grades, what you wanted to be when you grew up, etc.).

WARM-UP

- Let's talk a little bit about back when you were in school. What was your favorite subject when you were in high school?
  - PROBE: History/Social Studies, Math, Science, Reading/English, Foreign Language, Music/Art, Gym?
  - Why did you like that subject?

- What subjects did you like the least? Why?

- Is there a subject that you took in school that, looking back on it, you wish you had learned better? Why do you say that?

- What is your child's favorite subject in school?
  - PROBE: History/Social Studies, Math, Science, Reading/English, Foreign Language, Music/Art, Gym?
  - How do you think your child ended up liking that subject?

- What subject does your child like the least? Why?

- Do your children know yet what they want to do when they're grown up?
  - What school subjects do you think your children will need to excel in to have a chance to go into their chosen line of work?
  - What subjects do you think your children could do without? Why?

- When you help your child with their schoolwork, what is *your* favorite subject? Why? What is it that you like about that subject?
  - How did you end up liking that subject? Was it because of a certain teacher? A certain project?

- What subject do you *least* enjoy helping your child with? Why?

CAREERS

- Let's talk about your children and how they may choose their careers. What do you think your children want to become when they grow up? Have they already decided what they want to do when they grow up?
  - IF CHOSEN, ASK: Why do you think they have chosen that field? Do you think you will be able to do it? What will they need to do to go into that field?
  - IF NOT CHOSEN, ASK: Why do you think they have yet to choose?

- Think for a moment about some reasons you would want to have a certain kind of job or career. . . . What are some reasons why someone might try to have a certain job or career? GO TO BOARD, WRITE.
  - PROBE: Satisfaction? Celebrity? Recognition (honors, awards)? Interesting work? Money? Good career? Good lifestyle? Challenging? Good opportunities? Able to create things that will last? Competitive?

- Have you ever spoken with your children about what they want to become or what subject he or she wants to study in college?
  - What was this conversation like?
  - How much influence would you say you have on whether your (son or daughter) goes to college?

- Let's think again about when you were growing up. . . . Did you know anyone who had a job that was similar to the one you are doing now?
  - What was that person like?

ENGINEERING

- Now we're going to talk about another topic. . . . Engineering. What are the first words or phrases that come to mind when you think about 'engineering'? WRITE ON BOARD. PROBE FOR AS MANY AS POSSIBLE.
  - PROBE: Are there any positive words or phrases that come to mind when you think about engineers or engineering? How about negative words?

- What kind of person is an engineer? What traits and characteristics does an engineer have? PROBE FOR EXAMPLES.

- Do you know anyone who is an engineer? What does that person do? What is that person like?
  - PROBE: Can you name any engineers who are widely known?

- What are some examples of engineering at work today? WRITE ON BOARD
  - PROBE: What are the most interesting things on this list? Why? What skills would a person need to be able to do those things? What kind of person does those things?

- DISTRIBUTE HANDOUTS: I have something I would like you take a look at. Write your first name and your last initial at the top of the sheet. Here are some examples of engineering at work today. I'd like you to circle the ones you find most interesting or appealing, and cross out the ones you find very boring or least appealing. And when you've circled and crossed out some of the items on the list, I want you to number 1, 2,

3 the three most interesting or appealing of the things on this list.
  – PROBE: What did you pick as the most interesting thing on this list? Why? What skills would a person need to be able to do those things? What kind of person does those things?

- What's the difference between a scientist and an engineer? Is there any difference? What does a scientist do that an engineer doesn't do? What does an engineer do that a scientist doesn't?

- Now I'm going to read you a list of descriptions and I want you to tell me if it's more appropriate for scientists or engineers. . . . We can only give each description away once. . . Would you say scientists or engineers are better described as . . . Designers? Creators? Inventors? Lab technicians? Planners? Leaders? Followers? Original thinkers? Problem solvers? Hard working? Get results? Have a positive effect on people's everyday lives? Innovative? Successful?
  – PROBE FOR EACH: Why does that describe engineers/scientists better?

- Some people have said that engineers are 'real-world scientists.' What do you think that means? Do you agree? What does 'real world' mean?

I'd like to ask you about some other things that people have said about engineers and engineering. . . .

- Some people describe engineers as creative problem-solvers. They describe engineers as having a vision for how things should work, and they ask questions like 'how does it work?' 'what will happen if . . . ?' and they work with other smart people to design and build new things and solve problems.

  - PROBE: Is that description appealing to you? What is appealing about that? What are some kinds of examples of that kind of person?

- Some people describe engineers as being free to explore, and looking for better ideas, constantly learning new things, and they are never bored because there are always problems to find that need solving. Engineers are always being challenged and inspired to keep exploring.
  - PROBE: Is that description appealing to you? What is appealing about that? What are some kinds of examples of that kind of person?

- Some people describe engineers as making a world of difference because they're able to shape the future, have a direct effect on people's everyday lives, and solve tomorrow's problems today.
  - PROBE: Is that description appealing to you? What is appealing about that? What are some kinds of examples of that kind of person?

- What kind of careers do you think engineers have?
  - PROBE: How much money do they make? Do they work insane hours? Do they get to travel? Is their work interesting?

- Do you think engineering would be a good career for your child?
  - RETURN TO LIST OF CAREER ATTRIBUTES ON BOARD, ASK: Does a career in engineering have any of these career attributes?

- I want you to turn your handouts to the last page now. I want you to imagine that you are in charge of a marketing campaign to promote to young people to consider becoming an engineer or studying engineering, and your job is to write a slogan to

promote others to consider becoming an engineer. On the second set of lines, I want you to write down what you think the best image or photograph should go with your slogan.

CHECK IN BACK ROOM FOR OTHER QUESTIONS.

WRAP UP

- What did you write for a slogan? What image or photograph did you choose? Why?

Thank and dismiss.

D FOCUS GROUPS: MODERATOR'S GUIDE—TEENS

INTRODUCTION **(5 MINUTES)**

- **Moderator introduction:** I represent GSG, an independent opinion-research firm that conducts discussion groups on various topics. We ask people their opinions about everything from hamburgers to cars.

- Explain the idea of the focus group. Go over features of the room, including:
  - One-way mirror—I have colleagues taking notes behind the mirror so that they do not disturb us. . . .
  - Camera/Microphones—This is being taped so that I don't have to take notes while you are all giving your opinions. . . . One ground rule: You must talk, and you must talk loud enough so we can all hear you.
  - Completely confidential. Your full names will never be used. We just want to hear your opinions . . . Not a classroom; There are no right or wrong answers.
  - If you have any questions or additional comments, please go right ahead at any time. We have a good deal of material

to cover in a short time; feel free to ask questions, but we will need to keep the conversation moving. . . .

- Introductions: First name (only), and background information (family, favorite subject at school, favorite television show, favorite site on the internet, etc.).

WARM-UP

- You told me what your favorite subject in school is. Tell me why that's your favorite subject.
  - What is it that you like about that subject? If you were trying to explain to someone else why they might like that subject, what would you tell them?
  - How did you end up liking that subject? Was it because of a certain teacher? A certain project?

- Now, what is your *least* favorite subject in school?
  - PROBE: History/Social Studies, Math, Science, Reading/English, Foreign Language, Music/Art, Gym?

- Let's talk about what your plans are, and ask a question you've probably been asked a few times. . . . What do you want to do when you grow up?
  - Why do you want to do that? Do you think you will be able to do it?

- Think for a moment about some reasons you would want to have a certain kind of job or career… What are some reasons why someone might try to have a certain job or career? GO TO BOARD, WRITE.
  - PROBE: Satisfaction? Celebrity? Recognition (honors, awards)? Interesting work? Money? Good career? Good lifestyle? Challenging? Good opportunities? Able to create things that will last? Competitive?

- Do you know anyone who has a job now that you would like to have yourself when you are older?
  - What is that person like? Why did that person succeed in making that career for themselves? What did that person do to get where they are?

- What school subjects do you think you will need to excel in to have a chance to go into your chosen line of work? Why? How do you like those subjects? Why?
  - What subjects in school do you think you could do without? Why?

- Have you ever spoken with an adult about what you want to become? Who did you talk to? PROBE: A parent? A teacher or a guidance counselor? A family friend?
  - What was this conversation like? Why did you seek that particular person out?

- Now we're going to talk about another topic. . . . Engineering. What are the first words or phrases that come to mind when you think about 'engineering'? WRITE ON BOARD. PROBE FOR AS MANY AS POSSIBLE.
  - PROBE: Are there any positive words or phrases that come to mind when you think about engineers or engineering? How about negative words?

- What kind of person is an engineer? What traits and characteristics does an engineer have? PROBE FOR EXAMPLES.

- Do you know anyone who is an engineer? What does that person do? What is that person like?
  - PROBE: Can you name any engineers who are widely known?

- What are some examples of engineering at work today? WRITE ON BOARD.

  - PROBE: What are the most interesting things on this list? Why? What skills would a person need to be able to do those things? What kind of person does those things?

- DISTRIBUTE HANDOUTS. I have something I would like you take a look at. Write your first name and your last initial at the top of the sheet. Here are some examples of engineering at work today. I'd like you to circle the ones you find most interesting or appealing, and cross out the ones you find very boring or least appealing. And when you've circled and crossed out some of the items on the list, I want you to number 1, 2, 3 the three most interesting or appealing of the things on this list.
  - PROBE: What did you pick as the most interesting thing on this list? Why? What skills would a person need to be able to do those things? What kind of person does those things?

- What's the difference between a scientist and an engineer? Is there any difference? What does a scientist do that an engineer doesn't do? What does an engineer do that a scientist doesn't?

- Now I'm going to read you a list of descriptions and I want you to tell me if it's more appropriate for scientists or engineers. . . . We can only give each description away once. . . Would you say scientists or engineers are better described as . . . Designers? Creators? Inventors? Lab technicians? Planners? Leaders? Followers? Original thinkers? Problem-solvers? Hard working? Get results? Have a positive effect on people's everyday lives? Innovative? Successful?
  - PROBE FOR EACH: Why does that describe engineers/scientists better?

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  - PROBE: How much money do they make? Do they work insane hours? Do they get to travel? Is their work interesting?

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to promote to other young people to consider becoming an engineer or studying engineering, and your job is to write a slogan to promote others to consider becoming an engineer. On the second set of lines, I want you to write down what you think is the best image or photograph that should go with your slogan.

CHECK IN BACK ROOM FOR OTHER QUESTIONS.

WRAP UP

- What did you write for a slogan? What image or photograph did you choose? Why?

Thank and dismiss.

E YOUTH TRIADS: MODERATOR'S GUIDE

INTRODUCTION

- Explain the idea of the group. Go over features of the room, including:
- Camera/microphones—This is being taped so that I don't have to take notes while you are giving your opinions. . . .
- One-way mirror—I have colleagues behind the mirror taking notes so that they do not disturb us. . . .
- This is not a classroom; and I am not a teacher; there are no wrong answers.
- Completely confidential. Your full names will never be used. We just want to hear your opinions. . . . There are no right or wrong answers.
- The microphone overhead. Please speak up when you talk so that we can all hear you.
- Even though you know each other and are friends, please be sure to let everyone say what he has to say. Please don't talk over one another.
- If you have any questions or additional comments, please go right ahead at any time. . . .

WARM-UP

To begin, I'd like to talk about you...

- First tell me a little about yourself, your name, where you live, where you go to school, and what your LEAST favorite subject in school is. . . .
  - PROBE: History/Social Studies, Math, Science, Reading/English, Foreign Language, Music/Art, Gym?
  - PROBE: Why don't you like that subject?

- How long have you been friends? How did you meet each other?

- You told me what your favorite subject in school is. Tell me why that's your favorite subject.
  - What is it that you like about that subject? If you were trying to explain to someone else why they might like that subject, what would you tell them?
  - How did you end up liking that subject? Was it because of a certain teacher? A certain project?

- Have you ever taken a field trip or done a school project that you really enjoyed? Tell me about one good trip you took or project that you did. If it was fun, what made it fun? What did you learn?

CAREERS

- What do you want to do when you grow up?
  - Why do you want to do that? Do you think you will be able to do it?

- Do you know anyone who has a job now that you would like to have yourself when you are older?
  - What is that person like? Why did that person succeed in making that career for themselves? What did that person do to get where they are?

- Have you ever spoken with your mother or father or another adult about what you want to become when you grow up? Who did you talk to? PROBE: A parent? A teacher? A family friend?
  - What was this conversation like? Why did you talk to that person?

ENGINEERING

- Now we're going to talk about another topic… Engineering and engineers. I want you to write down for me what an engineer is and a few things about what an engineer does. What is an engineer? HAVE EACH CHILD WRITE DEFINITION AND DESCRIPTION.
  - What did you write? Why?
  - What kind of person is an engineer? PROBE FOR EXAMPLES.

- What kind of things do engineers do? Are there things that engineers do that you would like to do?
  - Are there activities that engineers do that you don't like or wouldn't want to do?
  - What do you think your friends would say if you told them you wanted to become an engineer?

- Do you know anyone who is an engineer? What does that person do? What is that person like?

VISUALS

- Now I'm going to show you some pictures of some different activities that engineers do. I'd like you each to pick two that you like or that you would like to do. **SPREAD PICTURES OUT ON TABLE.**

- Why did you pick those two images? **PROBE:** Have you done that activity before?
  - Why? What skills would a person need to be able to do those things? What kind of person does those things?

- **FOLLOW UP TO VISUALS:** Have you ever designed anything? Have you ever worked together with a team to solve a problem? Have you ever built anything? Have you ever done a science experiment? Have you ever written a computer program? Have you ever been on a construction site? Done a chemistry experiment? Built a model plane?

WAYS OF TALKING ABOUT ENGINEERING

I'm going to tell you a little about engineers and what they do, and, afterwards, I want you to tell me what you think. . . .

- Some people describe engineers as creative problem-solvers. They describe engineers as having a vision for how things should work, and they ask questions like 'how does it work?' 'what will happen if . . . ?' and they work with other smart people to design and build new things and solve problems.
  - What do you think? What's the first thing you think of after hearing that description? Is that what you think engineers are? What is creative problem solving?

- Some people describe engineers as being free to explore, and looking for better ideas, constantly learning new things, and they are never bored because there are always problems that need solving. Engineers are always being challenged and inspired to keep exploring.
  - What do you think? What's the first thing you think of after hearing that description? Is that what you think engineers are? What is exploring? What does it mean to be free to explore?

- Some people describe engineers as making a difference because they're able to help people by creating things that people will use, and have a direct effect on other people's everyday lives.
  - What do you think? What's the first thing you think of after hearing that description? Is that what you think engineers are? What does it mean to have a direct effect on people's everyday lives?

- Does engineering sound like something you would want to do?
  - Why? Why not?

WRAP UP

MODERATOR CHECKS BACK IN VIEWING ROOM FOR ANY ADDITIONAL QUESTIONS.

I just have a few more questions. . . .

Thank and dismiss.

F ONLINE SURVEY

GLOBAL STRATEGY GROUP
WWW.GLOBALSTRATEGYGROUP.COM

(INTRO)

Thank you for taking the time to participate in this online survey research project, which is sponsored by the National Academies, a non-governmental organization concerned with such issues as education, employment in scientific and technical fields, and the country's economic health. The answers you give will help the National Academies better understand how to address some of the challenges facing the United States. Your responses will be combined with those of other survey participants, and only those grouped responses will be shared with the National Academies. In other words, no one will know your individual responses to the survey questions.

To begin…
(INFORMED ADULTS SCREENER)
XI102. What is the last grade that you completed in school?

1.	Some grade school	TERMINATE
2.	Some high school	TERMINATE
3.	Graduated high school	TERMINATE
4.	Technical/Vocational	TERMINATE
5.	Some college	CONTINUE
6.	Graduated college	CONTINUE
7.	Graduate professional	CONTINUE

XI102. Generally speaking, how much attention do you follow the news, including what's happening local, statewide, or nationally -- a great deal, some, a little, not very much?

1. A great deal
2. Some
3. A little
4. Not very much
5. Not at all

XI103. Generally speaking, how involved are you in your community as a volunteer -- a great deal, some, a little, not very much?

1. Very involved
2. Somewhat involved
3. A little involved
4. Not very involved
5. Not involved at all

TERMINATE IF PUNCH 3-5 IN BOTH XI102 AND XI103

NEW YORK
895 BROADWAY, 5TH FLOOR
NEW YORK, NY 10003
212.260.8813
212.260.9058 FAX

WASHINGTON DC
4445 WILLARD AVENUE, SUITE 1040
CHEVY CHASE, MD 20815
301.951.5200
301.951.7040 FAX

CONNECTICUT
36 TRUMBULL STREET, 3RD FLOOR
HARTFORD, CT 06103
860.547.1414
860.548.0842 FAX

ARKANSAS
THREE FINANCIAL CENTRE
900 SOUTH SHACKLEFORD, SUITE 510
LITTLE ROCK, AR 72211
501.954.7878 FAX 501.954.9955

(ADULTS SCREENER)
XA1. Are you eighteen years of age or over?

1. Yes **CONTINUE**
2. No **TERMINATE**
3. Don't know/Refused **TERMINATE**

XA2. For each of the following professions or careers someone just starting out in the work world may choose, please indicate whether you think it would be a very good choice, a good choice, a fair choice, or a bad choice as a career or profession.
(SCRAMBLE CHOICES)

	Very Good Choice	Good Choice	Fair Choice	Bad Choice
Teacher	□	□	□	□
Doctor	□	□	□	□
Engineer	□	□	□	□
Lawyer	□	□	□	□
Architect	□	□	□	□
Scientist	□	□	□	□

(TEENS SCREENER)
XT1. Are you between the ages of 14 and 17 years of age?

1. Yes **CONTINUE**
2. No **TERMINATE**
3. Don't know/Refused **TERMINATE**

XT2. When you graduate high school, how likely is it that you will attend college?

1. Definitely will attend college
2. Probably will attend college
3. Chances are 50-50
4. Probably not
5. Definitely not

XT3. For each of the following professions or careers someone like yourself may choose, please indicate whether you think it would be a very good choice, a good choice, a fair choice, or a bad choice as a career or profession.
(SCRAMBLE CHOICES)

	Very Good Choice	Good Choice	Fair Choice	Bad Choice
Teacher	□	□	□	□
Doctor	□	□	□	□
Engineer	□	□	□	□
Lawyer	□	□	□	□
Architect	□	□	□	□
Scientist	□	□	□	□

(MAIN SURVEY)

1. Please indicate how important each of the following is [(FOR TEENS) to you] /[(FOR ADULTS) should be to someone starting a career] in considering which career to get into. (SCRAMBLE CHOICES)

	Extremely important	Very important	Somewhat important	Not that important	Not important at all
Salary	□	□	□	□	□
Recognition	□	□	□	□	□
Interesting Work	□	□	□	□	□
Challenging Work	□	□	□	□	□
Work that makes a difference, is meaningful	□	□	□	□	□
Availability of jobs in the field	□	□	□	□	□
Prestigious field	□	□	□	□	□

2. On the following one to ten scale, with ten being you know very well what a person in this profession does day-to-day and one being you don't know at all what a person in this profession does day-to-day, please rate your knowledge of each profession. (SCRAMBLE CHOICES)

	10 – Know very well	9	8	7	6	5	4	3	2	1 – Don't know at all
Teacher	□	□	□	□	□	□	□	□	□	□
Doctor	□	□	□	□	□	□	□	□	□	□
Engineer	□	□	□	□	□	□	□	□	□	□
Lawyer	□	□	□	□	□	□	□	□	□	□
Architect	□	□	□	□	□	□	□	□	□	□
Scientist	□	□	□	□	□	□	□	□	□	□

3. Thinking about the field of engineering… what words come to mind when you see or hear the word ENGINEERING? (OPEN END)

_____

_____

4. For each of the following, please indicate how well you think it describes engineers or the field of engineering. (SPLIT SAMPLE)
(SCRAMBLE CHOICES)

	Describes engineers or the engineering profession…			
	Very well	Somewhat well	Not very well	Not well at all
Creative	☐	☐	☐	☐
The work is rewarding	☐	☐	☐	☐
Fun	☐	☐	☐	☐
Get results	☐	☐	☐	☐
Hard working	☐	☐	☐	☐
Have a positive effect on people's everyday lives	☐	☐	☐	☐
Inventors	☐	☐	☐	☐
Leaders	☐	☐	☐	☐
Nerdy	☐	☐	☐	☐
Original thinkers	☐	☐	☐	☐
Problem solvers	☐	☐	☐	☐
Well-paid	☐	☐	☐	☐
Must be smart to get into this field	☐	☐	☐	☐
Must be good at math and science	☐	☐	☐	☐
Builds, constructs and makes things	☐	☐	☐	☐
Designs, draws and plans things	☐	☐	☐	☐
Sits at a desk all day	☐	☐	☐	☐
Mostly men	☐	☐	☐	☐
Mostly white	☐	☐	☐	☐
Well-respected	☐	☐	☐	☐
Requires too many years of school to get a degree	☐	☐	☐	☐
Entrepreneurial	☐	☐	☐	☐
Boring	☐	☐	☐	☐
Often work outdoors	☐	☐	☐	☐

5. For the following examples of engineering, please indicate how appealing it is. In other words, how well does it create interest for you in engineering? If you don't think it is a good example of engineering, please indicate that. (SPLIT SAMPLE) (SCRAMBLE)

	4 – Very appealing	3	2	1 – Not appealing at all	Not good example
Space exploration	☐	☐	☐	☐	☐
Designing video games	☐	☐	☐	☐	☐
Building an acoustically-perfect concert hall	☐	☐	☐	☐	☐
Designing the world's fastest plane	☐	☐	☐	☐	☐
Developing new foods	☐	☐	☐	☐	☐
Creating more advanced M.R.I. machines to do better brain and body scans to diagnose health problems	☐	☐	☐	☐	☐
D.N.A. testing	☐	☐	☐	☐	☐
Using D.N.A. evidence to solve crimes	☐	☐	☐	☐	☐
Building cars that run on alternative fuels	☐	☐	☐	☐	☐
Making cars safer	☐	☐	☐	☐	☐
Growing organs for transplants	☐	☐	☐	☐	☐
Making smaller, faster computer processors	☐	☐	☐	☐	☐
Protecting the rainforest by developing new ways to farm that don't require so much land	☐	☐	☐	☐	☐
Developing new fabrics	☐	☐	☐	☐	☐
Protecting the water supply	☐	☐	☐	☐	☐
Missile defense systems	☐	☐	☐	☐	☐
Smart traffic solutions	☐	☐	☐	☐	☐
High-definition television	☐	☐	☐	☐	☐
Building the world's longest bridge	☐	☐	☐	☐	☐
iPod	☐	☐	☐	☐	☐
Wind power	☐	☐	☐	☐	☐
Making homes safer	☐	☐	☐	☐	☐
Velcro	☐	☐	☐	☐	☐
Reducing air pollution	☐	☐	☐	☐	☐
Turning deserts into farmland	☐	☐	☐	☐	☐
Solar energy	☐	☐	☐	☐	☐
Machines that allow blind people to see	☐	☐	☐	☐	☐

6. Next you will read some statements that people have made about engineering. After you read each statement, please answer the questions below. (STATEMENTS SCRAMBLED)

   a. Engineers are creative problem-solvers. They have a vision for how something should work, and are dedicated to making it better, faster or more efficient.
   b. Engineers connect science to the real world. They collaborate with scientists and other specialists (such as animators, architects or chemists) to turn bold new ideas into reality.
   c. Engineering is essential to our health, happiness and safety. From the grandest skyscrapers to microscopic medical devices, it is impossible to imagine life without engineering.
   d. Engineers help shape the future. They use the latest science, tools and technology to bring ideas to life.
   e. Engineers make a world of difference. From new farming equipment and safer drinking water to electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways.

   Qa. How appealing this statement is to you, personally?

      1. Not appealing at all
      2. Not that appealing
      3. Somewhat appealing
      4. Very appealing

   Qb. How believable is this statement?

      1. Not at all believable
      2. Not that believable
      3. Somewhat believable
      4. Very believable

   Qc. How much do you, personally, care about what this statement says and the examples included in it?

      1. Do not care at all
      2. Don't care that much
      3. Care somewhat
      4. Care very much

7. And of these statements, which is most appealing to you, personally? (STATEMENTS SCRAMBLED)

   a. Engineers are creative problem-solvers. They have a vision for how something should work, and are dedicated to making it better, faster or more efficient.
   b. Engineers connect science to the real world. They collaborate with scientists and other specialists (such as animators, architects or chemists) to turn bold new ideas into reality.

c. Engineering is essential to our health, happiness and safety. From the grandest skyscrapers to microscopic medical devices, it is impossible to imagine life without engineering.
d. Engineers help shape the future. They use the latest science, tools and technology to bring ideas to life.
e. Engineers make a world of difference. From new farming equipment and safer drinking water to electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways.

8. And of these statements, which is <u>least</u> appealing to you, personally?
(STATEMENTS SCRAMBLED IN SAME ORDER AS IN Q.7)

9. The following are some taglines or slogans that might be used to describe engineering. Please indicate how appealing that tagline or slogan is to you, personally.
SCALE TO CODE:
1. Not appealing at all
2. Not that appealing
3. Somewhat appealing
4. Very appealing

(SLOGANS OR TAGLINES SCRAMBLED) (WILL APPEAR AS LIST ON SCREEN)

a. Bolder by design.
b. Because dreams need doing.
c. Turning ideas into reality.
d. Life takes engineering.
e. The power to do.
f. Behind the next big thing.
g. Designed to work wonders.

The following questions are for statistical purposes only.
ADULT
A101. What is your age?

1. 18-24
2. 25-29
3. 30-34
4. 35-39
5. 40-44
6. 45-49
7. 50-54
8. 55-59
9. 60-64
10. 65-69
11. 70+

TEEN
T101. What is your age?

1. 14
2. 15
3. 16
4. 17

ADULT
A102. What is the last grade that you completed in school?

1. Some grade school
2. Some high school
3. Graduated high school
4. Technical/Vocational
5. Some college
6. Graduated college
7. Graduate professional

ADULT
A107. Do you currently have any children under 18 living at home with you?

1. Yes
2. No

ADULT
A108. What is your current or most recent occupation?
(OPEN END)

D300. And just to make sure we have a representative sample of Americans, could you please tell me your race? (ACCEPT MULTIPLE RESPONSES)

1. Black/African-American
2. White/Caucasian
3. Hispanic/Latino
4. Asian-American
5. Other

D100. Gender

1. Male
2. Female

D400. STATE