

## **Attacking the workforce shortage one woman at a time**

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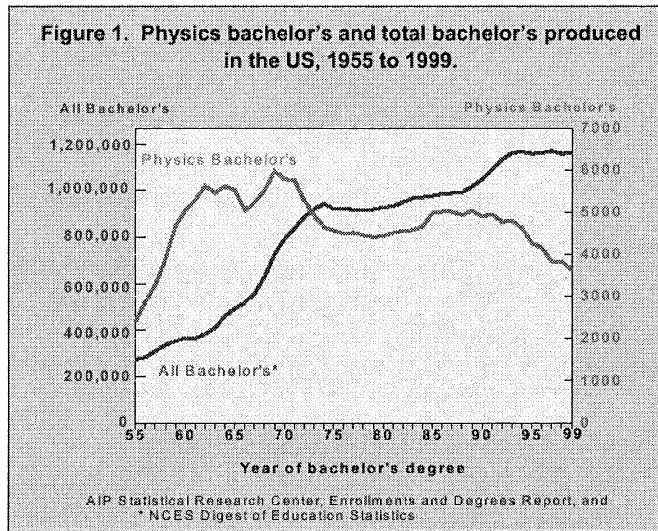
As optical technologies become increasingly important to a variety of industries, the demand for optical engineers, researchers, and technicians continues to grow. Workforce shortages are raising salaries and threatening to slow the growth of exploding markets. Although the slowdown of the telecom industry has reduced the pressure in the near term, optical technologies are as critical today as they were two years ago and the demand for a trained workforce will continue to grow. Statistics in the U.S. indicate that we will fail to meet the demands of industry unless the make up of the technical workforce undergoes dramatic changes through the increased participation of segments of the population that are currently underrepresented. In an effort to address this challenge, SPIE's Women in Optics (WiO) has developed a variety of programs to attract and retain women in optics-related careers.

Keywords: women, education, workforce, Women in Optics

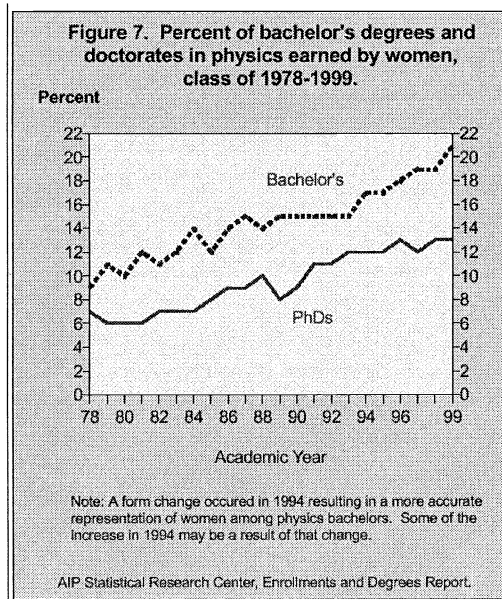
### **1. THE STATUS OF WOMEN IN SCIENCE AND ENGINEERING IN THE U.S.**

In April 2000 the White House report "Ensuring a Strong U.S. Scientific, Technical, and Engineering Workforce in the 21<sup>st</sup> Century" projected that if the demographics of the US science and engineering (S&E) graduates remains the same, the the U.S. will graduate 9% fewer than it did in 1996. Trained scientists and engineers are already in short supply, and the demand will continue to increase. The report concluded "it is in the national interest to vigorously pursue the development of domestic [science, technology, and engineering] workers from all ethnic and gender groups. We should pay special attention to groups that are currently underrepresented in the ST&E workforce, because it is with these groups that much of our nation's growing talent pool resides." Of the targeted groups, women present the greatest opportunity, being half of the population and only around 10% of the engineering workforce.

The most recent data on S&E graduates available from the National Science Foundation describes the graduating classes of 1995 and 1996. These classes combined produced approximately 708,000 BS degrees and 146,000 MS degrees in S&E disciplines. Of the BS degrees, 48% were awarded to women. Of the MS degrees, 40% were awarded to women. However, these numbers include the social and biological sciences, in which women are a majority of degree recipients. Most of the scientists and engineers working in photonics come from either electrical engineering or physics departments. If we take a closer look at those disciplines, the number of women is much lower. Only 12% of BS degrees and 15% of MS degrees in electrical engineering were awarded to women in 1995 and 1996. In physical science the numbers are higher—36% and 28% respectively. Although the percentage of physics degrees awarded to women reached an all-time high of 21% in 1999, the total number of physics degrees granted continues to decline.



**Figure 1.** The number of physics degrees awarded in the US has continued to decline, reaching the lowest level in several decades, despite the fact that the US is awarding more bachelor degrees than ever before.



**Figure 2.** The percentage of women graduating from physics departments with undergraduate degrees continued its steady climb in 1999, but not quickly enough to impact the decline in the total number of bachelor's degrees awarded in physics. The percentage of women among doctoral candidates has leveled off at 13%.

So why aren't students studying science and engineering? The problem certainly isn't a lack of jobs. According to the NSF, less than 3% of 1995&1996 S&E graduates are unemployed, and according to the AIP, less than 2% of 1997 physics graduates are unemployed.

Among 1995 and 1996 degree recipients, 24% of physical scientists and 17% of engineers are women. The percentage of women in the S&E workforce increases very slowly because women are still underrepresented in university programs. According to the NSF data, starting salaries for women graduating with bachelor degrees in engineering in 1995 and

1996 were equal to those of their male counterparts, but discrepancies still exist in science. This most likely reflects the fact that salary discrepancies are more prevalent today in academe than in industry. Where salary differentials exist, they get worse with degree level and years of service.

Although salary discrepancies have decreased significantly, women in S&E careers continue to struggle with prevailing attitudes about science and engineering. According to “Women in Technology Leadership”, published by Roper Starch Worldwide in 2001, 25% of professional men and 11% of professional women in the US believe that men are generally better qualified than women to work in the high technology industry and 69% of professionals believe that men “have the upper hand” in the high technology industry. Although 69% of professionals believe that there are too few women in technical leadership positions, 39% of professional men think the current number is “about right”. The result of this is lower retention for women in technology careers--56% of women say they are very interested in continuing their careers in high tech, as compared to 69% of men.

Prevailing attitudes about engineering also affect young girls and choices they make that impact their future careers. As part of an Expanding Your Horizons program cosponsored by SPIE, classes in various S&E disciplines were offered to middle school girls. The class labeled ‘engineering’ only attracted one student, while classes involving environmental science, medicine, and computing attracted between 10 and 20 girls each.

Although the percentages of women in S&E continue to increase slowly, the current pace is not sufficient to impact the workforce shortage. The potential of women’s participation to impact the shortage will not be realized unless there is a significant increase in the number of women entering the S&E pipeline. And once they are in the pipeline we need to keep them there. Women drop out in higher numbers than their male counterparts at all stages of the S&E pipeline—including once they have entered the workforce. In order to get more women into the pipeline, young women need role models. Women’s low representation in the S&E workforce makes those role models difficult to come by. SPIE’s Women in Optics working group brings female students and professionals of all ages together in an effort to combat this problem within the optics and photonics pipeline.

## **2. GOALS AND PROGRAMS OF SPIE’S WOMEN IN OPTICS**

WiO was formed in 1997 as a membership-based group, similar in organization to SPIE’s technical groups. It is governed by an elected core group consisting of 6 voting members, including a chair. The group meets twice per year—at SPIE’s annual meeting in the summer, and at the Photonics West meeting in the winter. The primary purpose of this governing body is to organize events at SPIE meetings that raise the visibility of women working in optics and give female meeting attendees—both students and professionals—an opportunity to network.

WiO organizes lunch or dinner gatherings at SPIE meetings all over the world. These informal meetings provide students and young professionals an opportunity to form relationships with established engineers and scientists who serve as mentors and role models. These types of relationships have a significant impact on the probability that the younger women will remain in the field. The outcome for participants is sometimes as concrete as learning about a job or business opportunity from someone at the dinner. Other times its just going home knowing that there are other women succeeding in and enjoying technical careers.

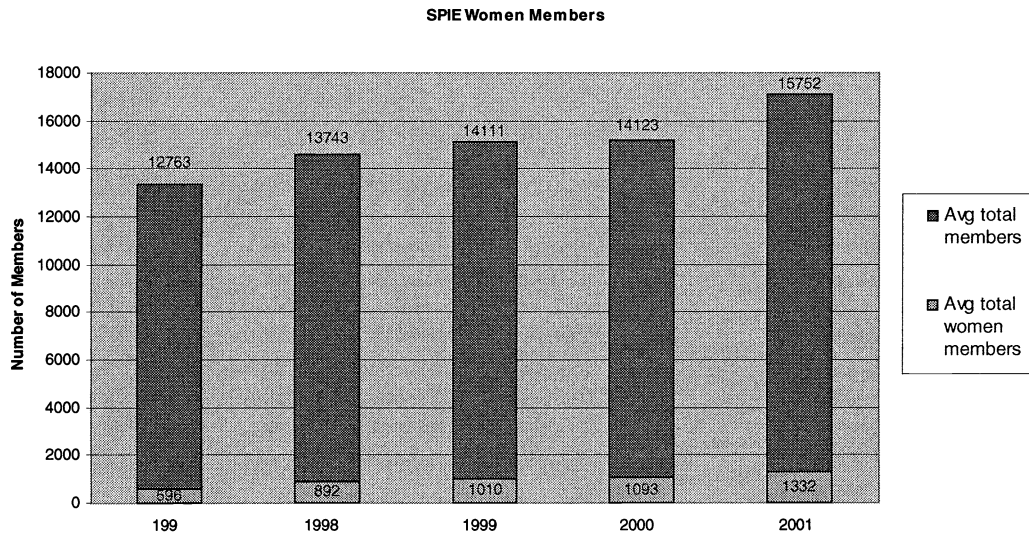
Members of WiO can also participate in more formal mentoring relationships through MentorNet ([www.mentornet.net](http://www.mentornet.net)), an e-mentoring program for women studying math, science, and engineering. WiO is a financial sponsor of MentorNet and holds mentor drives at SPIE meetings. Female student members of SPIE are eligible to sign up for mentors through the program.

WiO also sponsors invited speakers at SPIE meetings. Speakers address one of three basic topics: technology, business or policy. For technical talks, a woman is invited to give an overview of her work. Unlike most of the talks conference attendees hear, these are not aimed at an audience of people doing similar work, so they provide an opportunity for participants to learn about an area of photonics outside their expertise. These talks raise the visibility of women and their work, one woman at a time. The business-focused talks have a similar impact, while also providing practical information in the form of market analyses, business strategies, or career development tools. Policy talks generally focus on issues of

particular interest to women in technical roles. Over the last 3 years we have studied research on the status of women in science, reviewed children’s books about science and engineering aimed at grade-school girls, and shared ideas with representatives from other women’s organizations during these talks. WiO talks are advertised to all conference attendees and attract both men and women.

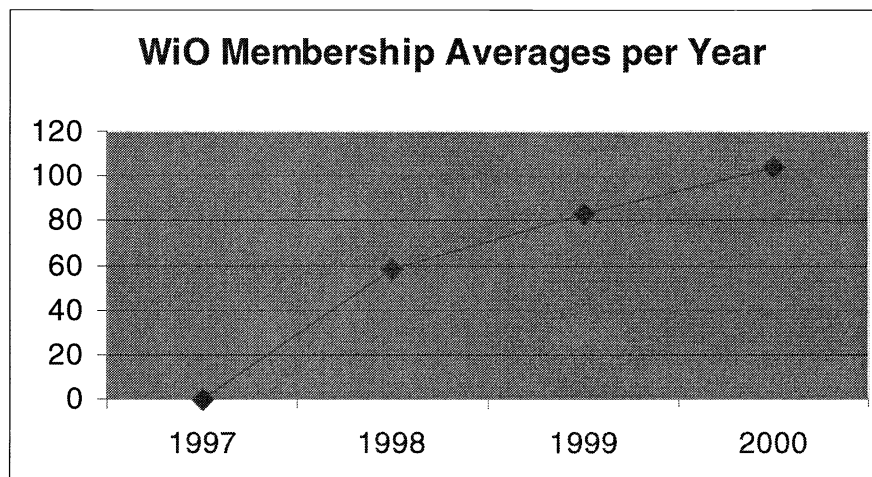
### 3. WIO’S ACCOMPLISHMENTS AND FUTURE

One of WiO’s goals is to get more women involved in SPIE. In 1997 only 4.5% of SPIE’s members were women. Since then the number of female members has more than doubled, raising the percentage to 8.5%, more closely representing women’s participation in the field. In that same time period, the number of women serving in SPIE governance has tripled—from 7 in 1997 to 21 in 2001. There are women serving on almost all SPIE committees, women are well represented on the board of directors, and for the first time there is a woman in SPIE’s presidential chain.



**Figure 3.** Since 1997, the percentage of SPIE members who are women has increased from 4.5% to 8.5 %.

In 2000, WiO averaged just over 100 members—about 10% of SPIE’s female membership. This year WiO aims to increase that percentage significantly through stepped up membership campaigns and the introduction of new member benefits, including a quarterly newsletter.



**Figure 4.** WiO membership continues to climb. In 2000, about 10% of SPIE's female members were also WiO members.

In addition to increasing membership, WiO's short term goals include the establishment of a WiO chapter in Europe and the introduction of programs aimed at women business owners. With only one part-time staff person supporting WiO, the organization is dependent on its volunteers to help organize events and establish new programs. These new initiatives will require growing WiO's volunteer base, which is why increasing membership is the top priority in 2002.

From beginning of studies to the end of their careers, women do not often chose, and when they do, they do not often persist in engineering careers. The reasons for this still evade us. Clearly, there are aspects to the training and climate that are not female friendly. SPIE's Women in Optics aims to respond in a personal way to women working in optics through informal networking and non-regimented programs. In our efforts to increase the participation of SPIE's female members, we have seen that personal appeals for volunteers that are made to individuals are infinitely more effective than generic global messages.

A recent example of success occurred when a high school teacher contacted SPIE staff about finding mentors for two of her female students. Within a few days a couple of us WiO members had volunteered and these students now have a direct communication line with women in industry. We are pleased to have this opportunity to show these two young women by example and encouragement that a career in optics is rewarding and exciting. For young girls, it is often small experiences like this that make the difference between success and failure.

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