Introduction

Many recent surveys and studies conclude that STEM (Science, Technology, Engineering, and Math) disciplines and industries remain challenging environments for women. Have you ever wondered how the optics and photonics community compares?

The SPIE Women in Optics Task Force was formed to answer this question, and to determine how the professional environment and culture of the optics and photonics community can better enable equal opportunities, rewards, and recognition for its members, independent of gender. In order to achieve this goal, the Task Force is focused on identifying and recommending specific and measurable steps our community can take to improve ongoing advocacy and career assistance for women and attract more women to pursue optics and photonics careers.

Meeting this objective in a comprehensive matter meant the Task Force needed data that offers insight into the issues facing current and future generations of women in optics. The Task Force worked with SPIE staff to develop a series of questions that would help us characterize and understand gender equality issues in our community. To maximize exposure and responses, these questions were incorporated into the 2016 SPIE Global Salary Survey. We thank those of you that took the time to participate.

What you are holding in your hand is built on results obtained from that survey. Some of the results may be expected, but we think others will surprise you. We hope you view these results as we do—as a starting point to producing real and measurable change in our community.

So please, share this booklet with your friends, your colleagues, and others in your network. Check out our website (spie.org/WiOsurvey) and contribute to the global conversation (@WomenInOptics on Twitter). Tell us what you think, what your experience has been, and stay tuned for our future work. We want this to be the start of something big.

Thank you,

Julia Craven
SPIE Women in Optics Task Force, Chair
Sandia National Labs, USA
Background

This report is built from data gathered in the 2016 SPIE Optics and Photonics Global Salary Survey. The survey is the largest of its kind in the optics and photonics community, receiving nearly 7000 valid responses and representing 105 countries and a wide range of disciplines.

Unless otherwise noted, all salary data presented in this report is based on results from full-time workers. For a complete list of participant countries and details on survey methodology, please see page 19.
Key Findings

• Women represent a minority in the optics and photonics community, accounting for 17% of the survey respondents.

• Median salaries are 38% higher overall for men than for women. The salary gap is smallest during early career and grows over time.²

• Women’s representation in the workplace declines over time. At the earliest career stage, 26% of workers are women, but participation drops with increasing years on the job, reaching 11% for employees with thirty or more years at work.

• Women in the optics and photonics community are less likely to have children than men. This finding is particularly strong at mid-career stages, suggesting that many women leave the workforce after having children and don’t return.

• Men and women are similarly satisfied about most aspects of their careers—more than 90% of both genders enjoy their work and find it meaningful. In contrast, fewer women feel that they are paid fairly (69% women vs. 76% men), and that promotions are handled fairly at their organizations (59% women vs. 65% of men).

• Women value paid parental leave, job flexibility, and working remotely much more than men. Men value high pay more than women by a small margin.

• Women take much more parental leave than men, with higher-income European and lower-income Asian women taking more time off than their North American colleagues.

• North American women receive much lower levels of pay during parental leave than their higher-income European or lower-income Asian colleagues.
Pay and Representation

Women make up 17% of the respondents to the survey, though their representation varies greatly by country. Romania has the largest percentage of women working in optics and photonics (41%), with Russia anchoring the other end of the spectrum (15%). Women earn less than men overall, with respective median annual salaries of $48,000 and $66,240. On a country-by-country basis, women are closest to matching men's salaries in the United Kingdom (13% difference), while the largest disparity is in Taiwan (359%).

Sample Size and Salary by Gender

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>771</td>
<td>3844</td>
</tr>
<tr>
<td><strong>MEDIAN</strong></td>
<td>$48,000</td>
<td>$66,240</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>$56,272</td>
<td>$80,787</td>
</tr>
<tr>
<td><strong>STANDARD DEVIATION</strong></td>
<td>$48,350</td>
<td>$80,863</td>
</tr>
</tbody>
</table>

Tanya Monro working with a student in the optics lab at the Univ. of Adelaide, Australia.
## Median Annual Salary and Workforce Representation by Country

*Table includes countries with ten or more responses from women working full time.*

<table>
<thead>
<tr>
<th>Country</th>
<th>Women as Percentage of Workforce</th>
<th>Wage Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROMANIA (n=14W+20M)</td>
<td>41%</td>
<td>93%</td>
</tr>
<tr>
<td>POLAND (n=11W+32M)</td>
<td>26%</td>
<td>20%</td>
</tr>
<tr>
<td>PEOPLES REPUBLIC OF CHINA (n=54W+206M)</td>
<td>21%</td>
<td>20%</td>
</tr>
<tr>
<td>UNITED KINGDOM (n=38W+146M)</td>
<td>21%</td>
<td>13%</td>
</tr>
<tr>
<td>SPAIN (n=26W+105M)</td>
<td>20%</td>
<td>18%</td>
</tr>
<tr>
<td>ITALY (n=39W+161M)</td>
<td>20%</td>
<td>18%</td>
</tr>
<tr>
<td>GERMANY (n=65W+291M)</td>
<td>18%</td>
<td>37%</td>
</tr>
<tr>
<td>UNITED STATES (n=274W+1281M)</td>
<td>18%</td>
<td>46%</td>
</tr>
<tr>
<td>TAIWAN (n=10W+50M)</td>
<td>17%</td>
<td>359%</td>
</tr>
<tr>
<td>INDIA (n=15W+80M)</td>
<td>16%</td>
<td>70%</td>
</tr>
<tr>
<td>FRANCE (n=26W+139M)</td>
<td>16%</td>
<td>29%</td>
</tr>
<tr>
<td>RUSSIA (n=22W+126M)</td>
<td>15%</td>
<td>78%</td>
</tr>
</tbody>
</table>

“Sometimes being one of the only women in the room can feel like being a zebra in a herd of horses. Just keep in mind that zebras have better stamina and maneuverability. Bring a unique perspective to each challenge and don’t be afraid to try something just because no one has done it before.”

– *Marla Dowell*, Division Chief, National Institute of Standards and Technology, USA
Women respondents in civilian government earn more than men, on average, but the opposite is true in all other sectors. At early-career stages, earnings are similar for both genders, but the gap grows with increasing years on the job.

“The wage disparity in North America is one of the highest, which says a lot about gender bias on this continent. Perhaps the most significant point can be seen in the figure that describes the median salary by gender and years employed. As a more senior level academic and researcher in North America, with 20+ years experience, it is critical that we see some sweeping changes to close this gap soon!”

– Anita Mahadevan-Jansen,
Orrin H. Ingram Professor of Biomedical Engineering, Vanderbilt Univ., USA
The percentage of women in the workforce declines over time. At the earliest career stage, 26% of workers are women, but participation declines to 11% for workers with thirty or more years of employment. Data presented on page 13 suggest that this decline may be related to women leaving their jobs after having children.
Job Satisfaction and Workplace Challenges

A significant majority of men and women in the optics and photonics community are satisfied with their working lives, feeling that they enjoy their work (96% of women and men), that their work is meaningful (93% of women and 96% of men), and that their work is respected by their peers (90% of women and 93% of men). However, fewer women feel that they are paid fairly (69% women vs. 76% men), and fewer women say that promotions are handled fairly at their organizations (59% women vs. 65% of men).

When asked about the top career challenges they face, men and women are in close agreement about the most important issues: lack of advancement opportunities (76% of women and 72% of men), stagnant wages (72% of women and 70% of men), and not enough time with family (69% of women and 71% of men).
In some areas, however, the gap is greater, with higher numbers of women experiencing challenges compared to men regarding unwelcome personal attention (27% of women vs. 18% of men) and not enough flexibility in their work schedule (38% of women vs. 32% of men).

**How often have you faced the following challenges in your career?**

*Percentages indicate total of people answering “sometimes” or “frequently.”*

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“**I’ve worked on optical and mechanical designs for anything from a simple mounted lens to complicated imaging systems and laser beam expanders. It is challenging work, but very rewarding when you get to see your design built and being used.”**

- **Katie Schwertz**, Optical Research Engineer, Edmund Optics Inc., USA
The preferences of women regarding the most important workplace benefits differ from men in a couple of notable areas. Women place more value on paid parental leave (78% of women vs. 63% of men) and the flexibility to work remotely (70% of women vs. 60% of men) compared to their male counterparts.

When thinking about your ideal workplace, what benefits are most important to you?
Percentages indicate total of people answering “important” or “very important.”

“Science and research need both genders to cooperate because men and women think differently, as we can see every day. And only the combination of different attitudes and ideas can lead to outstanding results.”

– Marketa Zikova, PhD Student in Physical Engineering, Czech Technical Univ. in Prague, Czech Republic
Children and Caregiving

Men in the optics and photonics community are more likely than women to be parents (50% of women vs. 66% of men). Of those respondents with children, 68% of the women are the primary caregivers of children under 18, compared to 50% of men. The higher likelihood of women being the primary caregivers of children holds true throughout all regions.

These results, coupled with the finding that women’s participation in the workforce declines over time, strongly suggest that a large number of women leave their optics and photonics careers after having children and don’t return.

View additional data about primary caregivers, parental leave, and salaries at: http://spie.org/WiOsurvey
Men take far less parental leave, on average, than women. Women in higher-income European countries took far longer leaves than their female colleagues in North America or lower-income Asian countries.\textsuperscript{4} For instance, 64% of higher-income European women took five or more months off versus 19% of North American and 25% of lower-income Asian women. A majority of North American women (59%) wish they could have taken more time off, while smaller percentages of higher-income European (36%) and lower-income Asian (38%) women share that feeling.

Unpaid leave is much more common in North America than Europe or Asia, where 30% of North American women took parental leave without pay versus 5% of lower-income Asian and 10% of higher-income European women.

\begin{tikzpicture}
\begin{axis}[
    ybar,\textwidth=\textwidth,\height=\textwidth,\footnotesize,
    enlarge y limits=0.25,\scaleobj{0.75}{
    symbolic y coords={I DID NOT TAKE ANY TIME OFF, A FEW DAYS, 1-2 WEEKS, 3-4 WEEKS, 1-2 MONTHS, 3-4 MONTHS, 5-6 MONTHS, 7-11 MONTHS, 12-18 MONTHS, MORE THAN 18 MONTHS},
    ytick=data,
    xtick=data,
    y tick label style={/pgf/number format/1000 sep={,}}
    ]
    \addplot[bars] coordinates {
        (I DID NOT TAKE ANY TIME OFF, 3)
        (A FEW DAYS, 4)
        (1-2 WEEKS, 3)
        (3-4 WEEKS, 4)
        (1-2 MONTHS, 8)
        (3-4 MONTHS, 19)
        (5-6 MONTHS, 29)
        (7-11 MONTHS, 17)
        (12-18 MONTHS, 10)
        (MORE THAN 18 MONTHS, 3)
        (WOMEN, 37)
        (MEN, 17)
    };
    \addplot[fill=gray!50] coordinates {
        (I DID NOT TAKE ANY TIME OFF, 3)
        (A FEW DAYS, 4)
        (1-2 WEEKS, 3)
        (3-4 WEEKS, 4)
        (1-2 MONTHS, 8)
        (3-4 MONTHS, 19)
        (5-6 MONTHS, 29)
        (7-11 MONTHS, 17)
        (12-18 MONTHS, 10)
        (MORE THAN 18 MONTHS, 3)
        (WOMEN, 37)
        (MEN, 17)
    };
\end{axis}
\end{tikzpicture}

Thinking about the birth of your last child, how much time did you take off from work for maternity/paternity leave?

“I faced my biggest obstacle when I became a mother during my research associateship at Stanford University. With time, I managed to reconcile career and family life by growing stronger from this challenge, becoming braver, more considerate and smarter on how to manage time. I also learned how to ask for help.”

– Seongsin (Margaret) Kim, Associate Professor, Univ. of Alabama, USA
“Workplace discrimination and work-life balance are not women-only problems, even though women suffer it the most and are often expected to choose between career and family. As the father of a young child, I saw firsthand the bias you face opting for parental leave. Companies should prove to their employees that, YES, you actually can have it all, family AND career.”

– Clément Fallet, System Physicist, Bioaxial, France
### Percentage of Pay Received During Parental Leave, by Region

*Table includes regions with 20 or more women in the sample.*

<table>
<thead>
<tr>
<th></th>
<th>ASIA, LOWER INCOME</th>
<th></th>
<th>EUROME, HIGHER INCOME</th>
<th></th>
<th>NORTH AMERICA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>0% (MY LEAVE WAS UNPAID)</td>
<td>5%</td>
<td>4%</td>
<td>10%</td>
<td>7%</td>
<td>30%</td>
</tr>
<tr>
<td>LESS THAN 10%</td>
<td>2%</td>
<td>5%</td>
<td>6%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>10-24%</td>
<td>10%</td>
<td>6%</td>
<td>4%</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>25-49%</td>
<td>12%</td>
<td>5%</td>
<td>12%</td>
<td>3%</td>
<td>9%</td>
</tr>
<tr>
<td>50-74%</td>
<td>7%</td>
<td>5%</td>
<td>19%</td>
<td>12%</td>
<td>19%</td>
</tr>
<tr>
<td>75-99%</td>
<td>19%</td>
<td>9%</td>
<td>11%</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>100%</td>
<td>45%</td>
<td>66%</td>
<td>38%</td>
<td>67%</td>
<td>30%</td>
</tr>
</tbody>
</table>

“As a father of four children, in a family with two working parents, childcare was a constant challenge. We were fortunate to maintain our careers while raising a family, but it was difficult due to a lack of forward-thinking family leave options. Companies should provide more flexible policies, and not have employees choose between family and career.”

*– Jim McNally, Director of Strategic Development, Applied Technology Associates, USA*
What Can We Do?

The enthusiasm for a career in optics and photonics are universal—both men and women report high levels of job satisfaction. And yet uneven representation in the field is nearly universal. Women are underrepresented in our community, with attrition in the field surfacing as a core issue. How do we attract women to a career in optics and photonics, then keep them in our workforce?

SPIE encourages the optics and photonics community, at individual and organizational levels, to take actionable steps to reduce the inequality in pay, support work-life balance, and increase access to leadership opportunities for women in optics.

INDIVIDUALS:

• Share the opportunities and benefits of the rewarding field of optics and photonics with young people.
• Challenge your own assumptions about work-life balance.
• Encourage women in your community to consider a career in STEM.
• Initiate conversation with your employer about your career goals and express an interest in promotion opportunities.
• Advocate for a work environment that offers equal opportunities and benefits regardless of gender.
• Become informed about public policy issues in the science community and participate in advocacy efforts.

“Being a woman pursuing a professional career mostly dominated by men was a challenge rather than an obstacle. We equally are gifted with the ability to think, learn, and communicate, and it is up to each of us to design our own road map to the future.”

– Fahima Ouchen, Senior Research Engineer, Univ. of Dayton Research Institute, USA
ORGANIZATIONS:

• Generate a work environment that encourages women to remain in the workforce and seek promotion opportunities.
• Seek to expand and retain the number of women in leadership roles in the workforce.
• Offer internship opportunities for women early in their careers, mentored by management or senior leadership.
• Provide equal and expanded maternity and paternity leave benefits, including part-time employment and job flexibility for all parents.
• Identify areas for improvement. Conduct self-audits on:
  - Salaries: male vs. female in equivalent roles
  - Percent of women in STEM positions
  - Percent of women in leadership positions

Overall, the SPIE Women in Optics Task Force encourages all members of our community to take steps towards gender equality in our vibrant, dynamic field.

“From outreach activities that allow us to strengthen children’s love of science, to our professors and the lab; it is important to have female role models at every stage in our career.”

– Cristina Solano, Outreach Coordinator, Ctr. de Investigaciones en Óptica, A.C., Mexico

“I wish someone had told me not to sweat the small stuff earlier in my career. Find a field you enjoy, work hard, and do your best. It is also important to react to opportunities, help and collaborate with your colleagues, and treat everyone as a team member with potential for significant contributions.”

– Maryellen Giger, A.N. Pritzker Professor of Radiology/Medical Physics, The Univ. of Chicago, USA
Methodology and Footnotes

In January 2016 SPIE sent email survey invitations for the Optics & Photonics Global Salary Survey to a large subset of its global database. Response was voluntary and open. Results were filtered to yield 6793 valid responses. Responses from employed respondents lacking salary data were removed, as were duplicates and responses from retirees. This report is built from this data. For further information about methodology, https://spiecareercenter.org/survey/13.

ENDNOTES:

1. This list includes valid responses from full-time, part-time, and student respondents. United States (1901), Peoples Republic of China (536), Germany (472), India (267), Italy (255), Japan and United Kingdom (251), France (244), Russia (230), Spain (178), South Korea (167), Canada (125), Taiwan (109), Netherlands (105), Mexico (84), Switzerland (76), Israel (73), Belgium (71), Poland (69), Australia (67), Brazil (66), Sweden (64), Turkey (62), Czech Republic (51), Colombia, Singapore, and Ukraine (47), Romania (45), Portugal (41), Malaysia and South Africa (39), Greece (36), Algeria (33), Austria (31), Finland and Pakistan (29), Denmark and Egypt (27), Ireland (26), Chile (24), Hungary (20), Lithuania (19), Saudi Arabia (18), Hong Kong SAR and Indonesia (16), Belarus, Iran, Slovenia, Bulgaria, Latvia, and New Zealand (12), Argentina and Slovakia (11), Thailand and Tunisia (10), Iraq, Morocco, Philippines, Estonia, Serbia, and United Arab Emirates (8), Norway and Vietnam (7), Armenia and Nigeria (6), Bangladesh, Cameroon, Jordan, Kazakhstan, Kenya, and Moldova (5), Venezuela (4), Croatia, Cyprus, Georgia, Lebanon, and Peru (3), Azerbaijan, Ecuador, Ethiopia, Ghana, Kuwait, Kyrgyzstan, Macau SAR, Nepal, Oman, Qatar, Sri Lanka, Sudan, and Zimbabwe (2), Botswana, Djibouti, Iceland, Libya, Luxembourg, Macedonia, Malta, Mongolia, Montenegro, Palestine State, Rwanda, Senegal, Tanzania, Uzbekistan, and Zambia (1).

2. U.S. dollars are used throughout. Local currencies were converted using January 2016 market exchange rates. Salary figures include total yearly compensation, both base pay and bonuses. Unless otherwise noted, all data on pay is drawn from full-time employees. Full-time employees are those who indicated working 35 or more hours per week.

3. The countries cited in this paragraph are from a subset with at least ten women full-time employees responding to the survey.

4. North America is comprised of the United States and Canada. Mexico is included in the Latin America and Caribbean category. Europe and Asia are composed of countries spanning a wide range of income levels, even when subdivided into higher- and lower-income groups. Higher- and lower-income subcategories are based on the World Bank’s threshold for high income countries, $12,736 per capita GNI. This threshold is used throughout this report when referring to “higher-income” and “lower-income” countries. For data on per capita GNI, see http://data.worldbank.org/indicator/NY.GNP.PCAP.CD/countries. For World Bank country income categories, see http://data.worldbank.org/about/country-classifications

Kristen Maitland (right) with grad student Joey Jabbour at their lab at Texas A&M Univ., USA.
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ABOUT SPIE
SPIE is the international society for optics and photonics, an educational not-for-profit organization founded in 1955 to advance light-based science and technology. The Society serves nearly 264,000 constituents from approximately 166 countries, offering conferences and their published proceedings, continuing education, books, journals, and the SPIE Digital Library in support of interdisciplinary information exchange, professional networking, and patent precedent. SPIE provided more than $5.2 million in support of education and outreach programs in 2015.

For more information, visit www.SPIE.org.

www.spie.org/WiOsurvey

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