

## Ruth Kaufman – Past President of The Operational Research Society, UK

Gender inequality, inequity and exclusion in OR has long been an issue hiding in plain sight and this paper provides a significant opportunity to bring it into the spotlight. The paper touches only briefly on why inequity is important, and I want to discuss this in more detail.

Inequity matters in its own right: “fairness” is a legitimate, if hard-to-define, objective for any enterprise, and one that is increasingly being used in OR modelling. But it also matters because of its impact on the OR profession’s own effectiveness and efficiency. These two objectives have been at the heart of OR’s contribution to enterprise since its inception, so it should come naturally to OR professionals to ask how inequity affects the profession’s own ability to deliver impact. There are at least two considerations.

The first is that good OR people, and good OR outcomes, are scarce resources. It is sheer wastefulness to make it harder for some to participate effectively. Moreover it is wastefulness that ripples down the generations, as newcomers lose out on role models, and on the confidence that they “belong” and are welcome. We have a profession that aims to improve efficiency across the economy, yet fails to apply its skills to improving the efficient conversion of its own pipeline material into effective members of the community; a profession that aims to solve problems but is stymied by everyday problems such as integrating part-time working into a leadership position. We have the tools—let us apply them.

The second is the consequences of a male-dominated, gender-blind profession on the quality of OR impact. As the paper rightly identifies, there are few OR solutions in the literature that take a gender-lens. Maybe there are not many OR solutions that require one—a question which is in itself worth further exploration. But one area would definitely benefit from a gender-lens: the impact of gender in the consulting environment.

Many large organisations in business, industry and government are trying to attract and retain women, reflected in female-friendly Human Resources policies. But OR people are advisers and consultants. Their effectiveness is crucially determined, not by their own line management chain, but by the culture and behaviours of the people they advise, and the people with whom they must collaborate; it is those individuals who will dictate the dynamics and outcome of the consultancy engagement.

The OR consultancy environment varies across sectors, business types and geographies, but in

male-dominated industries especially, female experiences of being patronised, obstructed or conversely being treated with kid gloves as an exotic charmer, are anecdotally common and unresearched. Management may provide support such as work-arounds, adjustments, possibly tailored training for the female consultant; or it may be left for the woman herself to struggle with. In either case, such responses are local and hidden. Research bringing this centre-stage as a potential factor in the success of OR consulting would be greatly welcomed.

## Anna Nagurney – Isenberg School of Management, University of Massachusetts, USA

First, I would like to thank the Editors of the Journal of the Operational Research Society for establishing the initiative of “Discussion Papers” and accompanying “Commentaries.” It is inspiring to have, as the first published discussion paper, the paper by Paula Carroll and Annunziata Esposito Amideo on Gender Equality. The paper provides a panoramic, multifaceted perspective, focusing on the history of OR and OR and gender equality, followed by a systemic literature review with the goal of uncovering gender perspectives on the history of OR, and an analysis of the latter as well as that of an online survey during the EURO 2021 hybrid conference on the gender dimension of OR careers. Each of these topics could merit an individual paper.

In terms of OR and gender equality, the authors focus on WISDOM (Women in Society: Doing Operational research and Management science), founded in 2022. It is a EURO Forum (general interest group) with aims to “support, empower and encourage the participation of ALL genders in OR within EURO” through certain actions. Other gender initiatives related to OR professional societies include WORMS (Women in Operations Research and the Management Sciences) of INFORMS, founded in 1995, and the UK Women in OR & Analytics Network (WORAN), established in 2020. Carroll and Esposito Amideo, with coauthors, earlier produced a white paper in 2020 (cf. Carroll et al. (2020)) emphasizing the gathering of data on gender and OR, since the number of women in OR “may be low.” They identify the percentages of board members of EURO national OR societies and reveal that 73% are male with 27% being female.

In addition, Carroll and Esposito Amideo note that another gender perspective on the OR community is the percentage breakdown of prize winners and that many more males have received awards in various EURO categories than females. They also

highlight some awards of the UK OR Society and of INFORMS and the first female recipients of them. I expand and add to the discussion by noting the following. INFORMS, with over 11,000 members now, started its Fellows program in 2002. 25% of its members identify as female (INFORMS (2024)). As of 2023, there were over 400 elected INFORMS Fellows, with approximately 10% of them being female. IFORS started its Fellows program in 2021 and there have been 5 females out of 36 thus recognized <https://www.ifors.org/ifors-fellows/> with Grazia Speranza, the first female, inducted in 2021. 7 out of the 58 IFORS (International Federation of Operational Research Societies) Distinguished Lecturers have been female <https://www.ifors.org/ifors-distinguished-lectures/>, with this award being initiated in 1999 and with the first female (Brenda Dietrich) receiving it in 2012. There have been 5 female (out of 45 total) Omega Rho Distinguished Lecturers <https://connect.informs.org/omegarho/distinguished-lectures/distinguished-lecture-series>, since 1983, with this lecture given at the annual INFORMS Meeting. Judith Liebman was the first female to receive this award in 2003, followed by Karla Hoffman, Margaret Brandeau, Anna Nagurney, and Laura Albert, the immediate Past-President of INFORMS. The Harold Larnder Prize, which requires a lecture, has been given annually since 1986 by the Canadian Operational Research Society, and, as of 2023, there have been 3 female recipients (Ailsa Land in 1994, Anna Nagurney in 2020, and Sophie D'Amours in 2023) out of a total of 37 awardees. [https://www.cors.ca/?q=content/harold-larnder-prize-0#:~:text=The Harold Larnder Prize is,at the CORS Annual Conference Clearly, as noted by Carroll and Esposito Amideo, more recently, females in OR have been increasingly recognized with awards; however, the percentages are still quite low.](https://www.cors.ca/?q=content/harold-larnder-prize-0#:~:text=The%20Harold%20Larnder%20Prize%20is,at%20the%20CORS%20Annual%20Conference%20Clearly,as%20noted%20by%20Carroll%20and%20Esposito%20Amideo,more%20recently,more%20females%20in%20OR%20have%20been%20increasingly%20recognized%20with%20awards;however,the%20percentages%20are%20still%20quite%20low.)

The WORMS Award has been given out annually since 2005 and according to its website: “celebrates and recognizes a person who has contributed significantly to the advancement and recognition of women in the field of Operations Research and the Management Sciences (OR/MS).” <https://www.informs.org/Recognizing-Excellence/Community-Prizes/Women-in-OR-MS/WORMS-Award-for-the-Advancement-of-Women-in-OR-MS#:~:text=The%20WORMS%20Award%20celebrates%20and,during%20the%20INFORMS%20annual%20meeting>. All recipients of the WORMS Award have been females.

In 2006, I chaired an ad hoc committee on diversity, having been invited by the then INFORMS President Mark S. Daskin. The report (cf. Nagurney (2006)) was quite eye-opening and revealed not only the number of INFORMS Fellows to that date that were female (about 5%) but also the number of major INFORMS award recipients that were female.

The data revealed that the recognition of females in OR for their scientific accomplishments, through 2006, was miniscule, and many recommendations were made, including the collection of gender-specific data. Slides to the accompanying presentation can be found here: <https://supernet.isenberg.umass.edu/Informs-diversity/DiversityPresentation112006.pdf> Since then, multiple females have been elected President of INFORMS, a welcoming fact. But, still, as mentioned earlier, only about 10% of the elected INFORMS Fellows are females. As for another type of board, and the composition of its membership, Newhouse & Brandeau (2021) published an illuminating study on the diversity of INFORMS journal editorial boards, the “gatekeepers,” of a total of 16 journals. They found not only that the editorial boards have low levels of diversity with women comprising just under 20% of the editorial board members and with fewer than 1% of editorial board members being underrepresented minorities, but 10 institutions (less than 5% of the total) are the home bases for more than 25% of the editors. Furthermore, Newhouse & Brandeau (2021) discovered a high level of connectivity between editorial board members (as measured by coauthor relationship) for some of the INFORMS journals. The latter, they noted, may give the appearance of an “in crowd” being influential. Specific recommendations were also made.

In their discussion paper, Carroll and Esposito Amideo recognize not only a gender imbalance on EURO society boards and in terms of awards, but also an imbalance in visibility. I believe that, in this dimension, professional OR societies can play a much greater role. For example, I served on the INFORMS History and Traditions Committee from 2016 and 2018 and I advocated for the inclusion of additional oral histories of females in OR. Despite my efforts, the website; see: <https://www.informs.org/Explore/History-of-O.R.-Excellence/Oral-Histories>, to-date, only includes 2 interviews (of Ailsa Land and Margaret Wright) and links to external interviews with Judith Liebman and Christine Shoemaker. The present History and Traditions committee of INFORMS is all male and, perhaps, that is playing a role. A remarkable initiative, in contrast, is one by Anand Subramanian, the conceiver of the outstanding Subject to (s.t.) podcast. According to Subramanian (2023), writing in the IFORS December newsletter, “The goal of the s.t. podcast is to inspire the next generation of operation researchers by means of informal yet in-depth conversations with great names in the field of OR in the form of oral history.” This series can be viewed both on YouTube and on various podcast platforms. As of January 2024 (Subramanian (2024)), Anand has conducted 80 interviews with 30 of them being female

guests (all have been operations researchers except for Anand's Mother, who has a PhD in the STEM field of chemistry), with nationalities associated with 16 countries. The Subject to YouTube channel currently has approximately 2,740 subscribers and nearly 70,000 views.

Furthermore, after mentioning several female prize winners in OR over time, the discussion paper authors highlight that only two females are among the top 100 cited in OR according to their h-index. Here, I believe, there may lie some confusion as to the identity of OR, which Carroll and Esposito Amideo call attention to early in their discussion paper. Not only do we have "operational research" but also "operations research" and I found that many highly cited scholars, including INFORMS Fellows, may list as their specialty on Google Scholar a methodology (optimization, for example) or application (transportation, supply chains, energy, healthcare) but not "Operations Research." This may also be an issue in their systemic literature review, which I comment on subsequently.

Carroll and Esposito Amideo, in their analysis of their systemic literature review, note the small number of papers at the gender/OR nexus. However, the INFORMS journal *Management Science* in 2022 published a virtual special issue of papers that had appeared in the journal in the past few years on Diversity, Equity and Inclusion <https://pubsonline.informs.org/page/mnsc/papers-on-diversity-equity-inclusion>. In this collection of 30 papers, I found 12 with "gender" in the title and topics investigated such as: "gender profit gap," "gender diversity in organizations," "gender quotas," "executive search and gender inequality," to name just a few. As I had mentioned earlier, this discussion paper, with its topics, could have yielded several papers. And, here, perhaps in the literature search, the confusion over the identity of OR may have arisen, with "Management Science" not considered. The discussion paper authors, in their finding a small number of papers, then expanded their search to analyze 38 History of OR papers, and applied a gender lens to this set of papers. They state that it is not surprising, given the military origins and history of OR, that this literature is male dominated. Nevertheless, it is quite troubling that this literature is "largely silent on the contributions of individual women on the role women have played in the founding and developing the OR discipline." The authors, in addressing their first research question: Is there a gender dimension to the history of OR?, report that, according to their findings, the OR history literature strikingly recognizes and honours individual males for their contributions. I personally learned a tremendous amount from my PhD advisor at Brown University, Stella Dafermos, who, in 1968, was the

second female to receive a PhD in OR in the United States. Sadly, she passed away at age 49 in 1990, and was honoured with an obituary in the journal *Operations Research* (Nagurney (1991)). I believe that, to date, Stella is the only female thus recognized. Her 1980 paper (cf. Dafermos (1980)) on traffic equilibrium and variational inequalities, published in the INFORMS journal *Transportation Science*, was chosen as one of the twelve most impactful ones in that journal in its 50th year history at that time; see <https://pubsonline.informs.org/page/trsc/classics>. Stella was a contemporary of Judith Liebman in their PhD studies at Johns Hopkins University and a true trailblazer.

The discussion paper's second research question, on whether there are gender differences in OR careers, based on the authors' survey, reveals that women in OR do "perceive barriers to career progression to a greater extent than their male colleagues." Interestingly, they find that a lower percentage of the females who responded have changed their affiliated institute. My recommendation in this dimension, which I have availed myself of, is to take shorter leaves from one's home institutions to engage in, for example, a Fulbright program or a Visiting Fellows program. Enhancing one's networks in this manner and the knowledge exchanges garnered can be incredibly rewarding both professionally and personally. A significant portion of the respondents to their survey, of over 78%, noted no gender-specific barriers to participating in OR and this is very good news. Further surveys and studies in this area are warranted. In a recent article in *Science Advances* (cf. Spoon et al. (2023)), based on a census of 245,270 tenure-track and tenured professors at United States-based PhD-granting departments, women were found to leave academia at higher rates than men at every career age. The researchers found that a harsh workplace climate, which can include feelings of not belonging as well as actual harassment, was the most common reason women left academia (Ye (2023)). In this dimension, professional societies and fora such as WISDOM, WORAN, and WORMS can and are providing valuable communities for females with accompanying encouragement.

There is much that can be done to increase the visibility of female operations researchers as well as to provide support for them. For example, INFORMS, in 2019, published an article by Kara Tucker, "Powerful, pragmatic pioneers," in *ORMS Today*. The article, as Women's History Month was approaching, was to spotlight 10 women—longtime, influential members of INFORMS and to also profile one "rising star." Having females keynote major conferences is also an important way of generating inclusiveness and enhancing visibility as is having

females represented on important panels. Recognition of excellent scientific work through best paper awards can also provide enhanced visibility and valuable support. Documenting the contributions of females in articles, and I would advocate also in books, as well as through oral histories and interviews expands their visibility and adds to outreach and education. Doing so, also helps to promote the historical contributions of females in OR and, in addition, strengthens the foundations for present and future generations of Operations Researchers. Articles such as the one by Amorosi et al. (2021) in a journal, also cited by Carroll and Esposito Amideo, can further record the achievements of female researchers and their journeys and inspire others. And, having female representation on prize committees can further expand inclusiveness and the diversity of award recipients.

Research on the gender and OR nexus, in turn, can be further stimulated through best paper prize competitions, such as the INFORMS DEI Best Paper Student Prize competition, initiated in 2022. A finalist paper in the 2023 competition, which I served on the selection committee of, was on the gender/OR nexus, and was entitled, “Gender inequality in research productivity during the COVID-19 pandemic.” It has now been published in *Manufacturing & Service Operations Management* (see Cui et al. (2021)).

Many thanks to the authors of this discussion paper for bringing out many issues that our OR profession should be and can be addressing. By working together, we can provide more innovative and creative solutions to problems that we are faced with now on our planet, including gender inequality. Gender equality, according to UNICEF (2017), as the authors state, means “that women and men, girls and boys, have equal conditions, treatment and opportunities for realising their full potential, human rights and dignity, and for contributing to (and benefiting from) economic, social, cultural and political development.” Gender equality is an essential component to the success of OR as a discipline and as a profession.

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