

WISE Initiative: Empowering Women in Industrial and Systems Engineering – Impacts, Strategies, and Future Plans

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Abstract

Women in Industrial and Systems Engineering (WISE) started as a social group within Virginia Tech (VT)'s ISE department in 2016 and became an official student group in 2021. Operating under the broader ISE department, WISE connects ISE's specialties like human factors and ergonomics engineering, operations research, manufacturing, and management systems. By uniting faculty, staff, and graduate and undergraduate students, WISE aims to develop well-rounded engineers and empower women in ISE. Our mission is to empower members through formal networking events, workshops, and informal gatherings. With over 65 active members, WISE hosts at least four events yearly and is working on creating an alumni network. This paper explores WISE's impact, strategies, and future plans, aiming to inspire similar initiatives elsewhere.

Keywords

Affinity group; Development; Engineering Education; Leadership; Women in industrial and systems engineering

1. Introduction

Women are underrepresented in science, technology, engineering, and mathematics (STEM) careers, much to the detriment of scientific and societal progress, and the field of Industrial and Systems Engineering (ISE) is no exception despite having Lillian Gilbreth as a prominent founder. From 2019-2024, Virginia Tech's (VT) College of Engineering highlights this disparity across

academic levels: approximately only 20.94% of undergraduate students, 24.19% of master's students, 22.14% of Ph.D. students, and 19.58% of tenure/tenure-track faculty are women [1]. While ISE features a higher percentage of women than engineering broadly, women are still not equally represented in the ISE discipline [2-4]. VT ISE, comparatively over the last five years, features women as 31.89% of undergraduate students, 25.24% of master's students, 35.21% of Ph.D. students, and 22.43% of tenure/tenure track faculty [1]. While the higher relative percentages in ISE are promising, our field has a way to go before we reach parity. Women encounter unique challenges as engineers. An example of this are the challenges in meeting graduation timelines within VT's Industrial and Systems Engineering (ISE) program. Specifically, female Ph.D. students, on average, require an additional full semester to complete their doctoral studies compared to their male counterparts [1]. Thus, we are compelled to examine the evolving ISE community landscape, particularly concerning actively championing and empowering women throughout their engineering endeavors. This is where WISE comes in.

Gender stereotypes negatively impact women's integration into engineering programs [5]. For instance, women who were perceived as beautiful were often considered less intelligent, and they faced micro-aggressive behaviors that hindered their participation in hands-on group work [5]. In addition to negative stereotypes regarding the engineering and mathematical capabilities of women, the culture of engineering departments and workplaces has been identified as a factor in women's decisions to withdraw from engineering programs [6, 7]. Promisingly, between 2009 and 2010, focus groups involving students from three southeastern universities in the US most frequently cited the "warmth" of ISE for the elevated representation of women in Industrial Engineering. "Warmth" is defined as having inviting atmospheres, approachable faculty and staff, and a valuable social network [2]. Comparable patterns were observed in focus group discussions with undergraduate women in IE in both 2018 and 2019: women exhibit a greater inclination towards fields where they perceive empowerment and support [8]. A pioneering residential program tailored for undergraduate women at the University of Wisconsin-Madison was established to bolster retention rates in science and engineering disciplines [9]. This innovative initiative offered a comprehensive array of professional development workshops, research forums, social gatherings, and more, resulting in markedly elevated GPAs among participants [9]. Moreover, participants reported social, emotional, and academic benefits of the program [9]. Taken together, we posit that departments play a role in fostering a welcoming atmosphere, and affinity groups supported by the department reinforce the notion that underrepresented groups are valued, welcomed, and embraced. In line with this vision, we offer a student affinity group

called Women in Industrial and Systems Engineering, or WISE, as a potential solution. WISE aims to unite students, faculty from various ISE disciplines, and departmental staff. Moving forward, WISE intends to establish an alumni network. The goal is to facilitate collaboration, provide support, and encourage participation across the ISE community.

In our research, we analyzed active affinity groups supporting women in engineering within the top 20 Industrial Engineering programs in the US, identified through the US News and World Report ranking in 2023. We sought organizations similar to WISE in supporting women in ISE. We employed a two-fold approach: 1) searching through DEI committee web pages and similar entities for available documents outlining initiatives and existing affinity groups and 2) conducting keyword searches like "Women in {Industrial Engineering, or Industrial and Systems Engineering, or Systems Engineering} at {University name}". Notably, most top IE programs had overarching support organizations for women in STEM or general engineering (SWE), rather than specifically in industrial engineering. Excluding VT only North Carolina State University mentioned specific affinity groups for women in ISE.

Our goal is to expand WISE into a national-level organization within IISE and encourage other universities to establish WISE chapters, thereby supporting women in ISE on a broader scale. Thus, this paper provides an overview of WISE's structure, the resources and support mechanisms WISE utilizes, and WISE's program offerings, aiming to guide other ISE departments in creating their own WISE groups. Additionally, we analyze survey data from WISE members and non-members to assess its effectiveness and outline future directions, including areas for improvement and expansion.

2. Why an Affinity Group

There are already professional societies for engineers broadly like the Society of Professional Engineers or for women within engineering broadly like the Society of Women Engineers. However, ISE stands out for its unique interdisciplinary nature and expansive scope within itself, within the array of engineering disciplines. At VT, ISE includes human factors engineering and ergonomics, management and systems engineering, manufacturing systems engineering, and operations research. The breadth of ISE underscores the necessity of fostering an ISE-centric community where students from various concentrations can seek professional guidance, engage with peers possessing a blend of engineering and human-focused skills (such as psychology), and collaborate to enrich their expertise and competencies within the ISE discipline. An ISE-

specific affinity group has opportunities to facilitate expressive social capital, fostering a sense of belonging and alignment by providing avenues for students to witness a diverse representation of individuals like themselves in their field [5].

Affinity groups provide multiple benefits for women in academia. They facilitate collaboration among students and female faculty members which enhances motivation and the sense of belonging for female students. A 2017 study reveals that female engineering students paired with female mentors reported heightened feelings of belonging and confidence in their field, along with expressing more ambitious career aspirations [10]. This sense of belonging, nurtured by university and departmental groups, has been linked to positive outcomes including higher student retention rates, increased graduation rates, improved academic performance, and enhanced emotional well-being [11, 12]. Additionally, the presence of affinity groups can cultivate a culture of collaboration, which proves especially advantageous for women who may feel marginalized or isolated within their academic environments, such as minority and first-generation students [11, 13]. Effective activities for promoting student socialization and enhancing student belonging include informal gatherings with peers and faculty, research trainings, and participation in professional conferences [12]. Thus, affinity groups tailored specifically for women in ISE emerge as a promising solution to bridge historical gender disparities as they can serve as vital networks for women to connect, exchange experiences, and collaborate to overcome both common challenges and obstacles unique to the female experience.

3. WISE at Virginia Tech – Program Description

3.1 Who WISE Serves

WISE serves as an affinity group dedicated to female-identified ISE students/faculty/staff and allies within the field of ISE at VT, extending membership to anyone interested in participating in its events. Within WISE, members benefit from both formal and informal support systems, including camaraderie, mentorship, and opportunities for knowledge acquisition, all tailored to address the unique challenges encountered by women in engineering. The VT ISE community includes undergraduate generalists, master's and Ph.D. students specializing in one of four concentrations: human factors engineering and ergonomics, management and systems engineering, manufacturing systems engineering, and operations research, and ISE faculty and staff. While various specialties within ISE have their own dedicated student groups (e.g., Human Factors and Ergonomics Society (HFES), Institute for Operation Research and the Management Sciences (INFORMS)), WISE aims to bridge the gap between these disciplines and facilitate

meaningful engagement between students and faculty across the entire spectrum of ISE. We propose that a mixed-specialty group comprising both graduate and undergraduate students fosters cross-disciplinary dialogue and interaction among these distinct groups and with faculty and staff. Such collaboration ensures the cultivation of well-rounded engineers, enhances mentorship opportunities, and enriches the camaraderie experience. As of the time of writing, WISE boasts 65 official members and extends its reach to countless others through inclusive events open to all, irrespective of membership status. Therefore, WISE serves over 230 female-identified undergraduate and graduate students in the ISE department, as well as any other students who wish to attend our meetings.

3.2 Creation and Organizational Logistics of WISE

WISE at VT initially began as an informal social group, with events as early as 2016, and was managed by graduate student volunteers with some financial support from the department. Unfortunately, the informal nature of the group made it difficult for WISE to have consistent events and student engagement across semesters, let alone academic years. This was largely due to a lack of a formal membership roster or an established leadership structure, meaning that as student leaders graduated or became too busy with their dissertations, there was no formalized process to hand over WISE and ensure smooth transitions of leadership. This issue was exacerbated by the group being known strictly through word-of-mouth, making it difficult to recruit new leaders and members. In 2019, only four students came to leadership meetings. Come early 2020, the COVID-19 pandemic shut down on-campus classes and events and WISE went on a brief hiatus. By the time VT campus reopened in 2021, many students who knew about WISE before COVID had graduated, including three of the four 2019 leaders. This posed a unique and new issue, with WISE in some ways starting from scratch within the student body. The remaining WISE student leader realized that for WISE to thrive, the group needed more formalized structures. The strategies to provide this formalization were: 1) establish WISE as an official VT student group, 2) create a permanent working relationship with the Diversity, Equity, and Inclusion committee in VT's ISE department, and 3) create a charter that outlines the official processes, programming, and expectations of WISE leadership. The three strategies are elaborated below.

Establishing WISE as an official VT student group afforded several advantages, including the affordance of significantly more access to campus resources, other funding mechanisms, and a page on the university's student-group website (GobblerConnect) as well as a membership to

have an independent communication electronic mailing platform. Establishing WISE as a student group required some VT procedures that are likely unique to each institution, thus we will not explain them in detail. The important part here is that the formalization process required other officers to be recruited (at least a treasurer and president are required, plus five other members), thus once the WISE application was accepted, the student group could hit the ground running.

Establishing a lasting partnership with the ISE Diversity, Equity, and Inclusion (DEI) committee capitalizes on existing departmental support, guaranteeing sustained financial backing and ensuring that women's voices resonate within the faculty-led committee. This collaboration strengthens WISE's ability to cater to the needs of VT ISE students. The continuity of this partnership is safeguarded by the responsibilities outlined in the official WISE charter, which include the WISE president's role as a student representative on the ISE DEI committee.

With resources available to student groups, the staunch support of our department head, and the financial assistance (\$750 annually) of the DEI committee, WISE now had the people and means to create some unique events and lay out its future via the charter. This charter provides the organizational structure necessary for WISE's sustainable presence. The charter formalizes and defines each officer role and its expectations, as well as outlines organizational standards for event type and frequency, defines a hierarchy for emergency mid-semester leadership handoffs, and defines the standard leadership handoff process. These components serve to make WISE transparent for prospective officers and to provide the structure necessary to ensure consistency of event offerings. To ensure operational effectiveness and agility, that all students who want to serve have an opportunity, and that all ISE disciplines are represented, there are several officer roles: Faculty advisor, President, Vice President, Treasurer, Secretary, Formal Event Chair, Social Event Chair, Human Factors Liaison, Management Systems Liaison, Operations Research Liaison, Manufacturing Liaison, Graduate Student Representative, and Undergraduate Student Representative. The aforementioned agility relates to the makeup of WISE officers each year. More specifically, if a Human Factors Ph.D. student is the president, then a Human Factors Liaison is not necessary (but still an option for other students), whereas if no officers are Operations Research students, then recruiting an OR student into a low-demand representative role can round out the representativeness of WISE. Note: Our faculty advisor also serves as a representative for faculty.

3.3 Programming and Events

WISE adopts a dual-strategy approach to event hosting, encompassing both social and formal gatherings. This approach is designed to cultivate social connections and foster professional development. Social events provide a platform for building camaraderie, facilitating networking opportunities, and promoting social engagement among WISE members and esteemed guest speakers alike. WISE hosts at least one formal and one social event each semester, totaling a minimum of four events a year. Examples of social events include:

- Happy Hour, an open event where all ISE students and faculty can go to a local restaurant as a large group and informally mingle (~20 students, ~3 faculty)
- Annual WISE dinner that is covered by WISE. This dinner is a closed, members-only event and serves as a targeted opportunity for specifically WISE members to connect with faculty, staff, and other students outside of their specialization or academic level (~25 RSVPs, ~5 faculty)
- Crafting Events, such as cookie decorating and Valentine's card making events, serve as social mixers with an opportunity to be creative (~20 students, ~2 faculty)

On the other hand, formal events provide opportunities for professional and academic development. These events have encompassed:

- Graduate Student Panel, an open event for all ISE students to learn about graduate school from the perspective of graduate students, professors, and academic counselors in ISE (~60 students have attended over two years)
- Negotiation Workshop, an open event for all ISE students to develop negotiation skills for prospective industry jobs and build confidence (~50 students attended)
- A Methodical Approach to your Dissertation: Conference and Practical Workshops, an open event for all potential and current PhD students, as well as advising faculty to learn effective ways of conducting research and drafting dissertations (~25 students, 2 faculty)

Whenever possible, WISE strives to provide 'mixed events' that seamlessly blend social and formal components. This entails adapting our existing events. For example, the first WISE dinner featured a 15-minute guest speaker presentation about her experiences as a woman in ISE, followed by open discussions and general mingling. While mixed events are generally dynamic due to being a varied implementation of another event type, WISE has one standing mixed event called Coffee Breaks that is organized in collaboration with the DEI committee. Coffee Breaks provide opportunities for casual interactions between department guest speakers and ISE

students over coffee and snacks (provided). Such Coffee Break events typically attract around 20 attendees, including 4 faculty members. Like Coffee Breaks, WISE conducts some co-events with other organizations at VT. Previous collaborations have included hosting events with HFES, Alpha Pi Mu, and the VT ISE DEI committee.

In addition to its event programming, WISE is committed to fostering diversity, equity, and inclusion within academia, and actively supports its members by offering scholarships to attend the Faculty Women of Color in the Academy (FWCA) Conference. This initiative is made possible through the generous additional financial support of the department's DEI committee (\$2,000). The FWCA conference is hosted annually by Virginia Tech, and through the collaborative effort between WISE and the DEI committee, 15 students have been granted registrations to the event over the past three years.

3.4 Survey and Results

To understand how well-informed department members are about WISE, their attendance at events, their event preferences, their hopes for future WISE directions, and their perceptions on WISE's impacts on their academic life, we surveyed all VT ISE faculty, staff, and students. The survey was fully completed by 22 members of the VT ISE community: 5 undergraduate students, 3 master's students, 10 Ph.D. students, 1 staff, and 3 faculty. Most of the survey respondents were either WISE members or had attended WISE sponsored events; however, we did get some feedback from prospective members (39%) as well. We had a good mix of graduate students and faculty across the different ISE concentrations offered at VT, with every concentration represented by at least one respondent, most were in human factors (43%) or management systems (31%). The majority of respondents identified as cisgender women (73%). Regarding race, the majority (40%) identified as Asian, followed by White (32%), Middle Eastern or North African (18%), and Black or African American (9%), no respondents identified as Hispanic, Latino, or Spanish Origin. Additionally, 28% of respondents identified as international, 19% as first-gen, 9% as low-income, and 6% as Pell Grant recipients.

Communication and Advertising: On a question allowing multiple selections, the majority (66.67%) of students reported learning about WISE through email advertisements, indicating the effectiveness of direct communication in reaching the target audience. Respondents also reported they were informed about WISE by faculty or staff members (33.3%) and word-of-mouth from other students (22%). Similarly, faculty reported primarily learning about WISE through faculty

meetings (66.67%), email advertisements (66.67%), and communication with another faculty or staff member (66.67%). These highlight the influence of institutional support and peer recommendations in spreading awareness within the student community. Surprisingly, only two students reported finding WISE through GobblerConnect, the central hub to find events and activities hosted by hundreds of campus organizations at VT. While WISE at VT has actively promoted its events via flyers strategically placed around campus and on social media platforms like Instagram and LinkedIn, these efforts contributed to a lesser extent, with minimal representation in the survey responses. These findings underscore the necessity of assessing the effectiveness of current outreach strategies and devising methods to enhance the utilization of these channels.

Event Preferences: In terms of which WISE events respondents preferred for professional development, 61% said mixed events (e.g. formal dinner with guest professors talking in a group discussion about their experiences as a woman in STEM). Social events (e.g. cookie decorating, hot cocoa mixer) were found to be the most enjoyable events amongst undergraduate and graduate students, followed closely by coffee breaks with guest departmental ISE speakers, and the WISE yearly dinner. Faculty respondents also found WISE social events to be the most enjoyable. Further, when asked which events WISE should do more of, social events were the most highly reported. Students and faculty reported wanting more events covering topics such as how to network, how to create a healthy work-life balance, and women's issues in the workforce.

Personal Development: All faculty respondents reported that WISE has positively impacted their personal or academic life and 70% of students reported the same positive impact of WISE. 37.5% of students said they felt like they got a little or a lot of exposure to different kinds of ISE students at WISE events, with 56% responding 'neutral.' 52.95% said they felt always or sometimes encouraged to share their ideas or concerns with WISE (33% of faculty), and 41.18% felt neutral due to not having ideas they wanted to share or feeling neither encouraged nor discouraged (66% faculty). On a free response question about what students liked most about WISE, responses included: "WISE makes me feel comfortable. In many classes I am the only female or one of two females. Without exposure to WISE, I would feel more alone and question my place in the department. WISE reminds me that I am valued and supported," and "I like that it gives spaces for women in ISE to connect," and "I get to meet other female students and hang out with them."

5 Discussion and Conclusion

WISE at VT has strategically charted a course for growth, aiming to create an inclusive and empowering environment for women in Industrial and Systems Engineering (ISE) while implementing initiatives that benefit all individuals within the field. Our survey results indicate successful strides in fostering encouragement and camaraderie among our members. To ensure continued positive strides, our survey also informs our future work.

WISE will continue to host recurring formal events to aid professional development. Moving forward, these workshops will include Networking, Work Life Balance, and Women's Issues in the Workforce. Perhaps in the future, these may even entail a WISE specific career fair with local industry. Given the popularity of mixed events, WISE will explore a 'lightning talk' workshop format to increase ease of inviting speakers and create a more relaxed atmosphere. WISE will continue to explore ways to strengthen camaraderie and further seek ways to promote well-being. This will entail more creative events (like cookie decorating). Further, WISE will begin exploring socially engaged events like making post cards for prospective high school women inviting them into engineering, or a menstrual product donation drive to address period poverty locally. Through this, WISE intends to explore collaborations with other student groups to address the intersectionality of our members (e.g., hosting co-events with the Queer and Trans People of Color at VT group and First Generation at VT group). WISE's most immediate venture will be to create an Alumni Network with early career and established women in industry and academia. This too will involve collaborations with the Emerging Leaders Board and the Engineering Young Alumni Council.

Our survey revealed that WISE's greatest weaknesses are in engaging staff and creating effective advertising. WISE will explore new avenues for event advertisements (e.g. GobblerConnect, the ISE department's rotating monitor advertisements, GroupMe). Further, WISE will conduct a secondary survey targeting staff specifically to ascertain their needs. Moving forward, WISE will conduct annual surveys of the VT ISE community to ensure WISE is adaptive and effective. Further, WISE will continue to monitor enrollment and graduation data for our department in tandem with this survey to understand WISE's overall effectiveness.

The continued expansion of WISE and its offerings is made possible by the unwavering support of our department head, the DEI committee, the fervent dedication of WISE officer members, and the \$750 allocated to us annually for routine use and \$2000 allocated for the annual FWCA conference. Building WISE as a recognized affinity group and officer roles as prestigious positions

of responsibility helps ensure quality and consistency of event offerings and leadership. WISE is working to establish a rotating series of events and themes that cycle, making it such that every workshop does not need to happen within one academic year.

We posit that for WISE to truly meet its potential, other institutions would need to institute their own WISE chapters. This could one day expand to IISE national as a recognized affinity group, with university level groups as official 'chapters.' Such breadth and expanse would foster national connection between women in ISE and it is our hope that this paper sparks interest for other ISE programs to create similar programs. To this end, we have outlined our support structures, event strategies, future plans, and a survey of perceptions and preferences regarding WISE at VT. Further, we offer additional materials on the [VT WISE website](#). There, you can find our charter which outlines the explicit responsibilities of WISE officers and the procedures for electing new officers. Please feel free to reach out to VT's WISE organization with any questions (womenISE-g@vt.edu).

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