IEEE FELLOW COMMITTEE

IEEE Fellow Strategic Planning Subcommittee (FSPS)

2016 REPORT

2016 FSPS voting members

1. Stefano Galli (FSPS Chair and IEEE Fellow Committee Vice-Chair)
2. Mariesa Crow
3. Serge Demidenko
4. Maria Sabrina Greco
5. Mark Karol
6. Dejan Milojicic
7. Amy Reibman (IEEE Fellow Committee Chair)
8. Tariq Samad

2016 FSPS non-voting members

1. Rosann Marosy (IEEE Fellow Activities Manager, staff)
2. Donna Dukes (IEEE Fellow Activities Administrator, staff)

From the IEEE Fellow Committee Operations Manual – Clause §2.1

The Fellow Strategic Planning Subcommittee is a standing committee of the IEEE Fellow Committee, and is responsible for addressing ongoing and new activities on an annual basis, including initiatives to improve the efficiency of and assure the fairness of the Fellow process, encourage nomination of qualified individuals among underrepresented sectors of the IEEE membership, and enhance the prestige of Fellow grade membership.

THE 2016 FSPS REPORT

IEEE FELLOW COMMITTEE

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Executive Summary

This report summarizes the activities of the 2016 IEEE Fellow Strategic Planning Subcommittee (FSPS), a standing committee of the IEEE Fellow Committee (IEEE FC).

The members of the 2016 FSPS were appointed by the FSPS Chair at the beginning of the calendar year. The FSPS transacted business via email and teleconference, discussed several items of strategic importance, performed an extensive analysis of Fellow nomination and elevation trends, and prepared several proposals to be presented at the October 2016 IEEE FC meeting for approval.

Two high priority items have been identified by the FSPS and have been addressed thoroughly:

- Item #1: Finding a solution to the problem of the ever-increasing number of nominations
- Item #2: Reforming the IEEE FC governance framework

Additionally, the following important items have also been addressed:

- Item #3: Improving communication w/Societies & Councils
- Item #4: Improving the quality of nominations
- Item #5: Increasing the pool of applicants from underrepresented demographics

Proposals for topics to be addressed by the 2017 FSPS are finally given in §6.

We summarize below the major findings and proposals for each of the five items listed above.

Item #1 – Finding a solution to the problem of the ever-increasing number of nominations

The number of nominations submitted every year has increased at an average rate of 3%/year over the past 18 years, becoming a critical issue for the IEEE FC. Past FSPSs have addressed this issue but most of the solutions that were proposed to reduce the workload on IEEE FC Judges have been rejected by the IEEE FC.

The 2016 FSPS proposes a workload reduction procedure which has been carefully crafted by performing an extensive data analysis and avoiding the pitfalls of past attempts. The workload reduction proposal includes three interconnected elements:

1. Impose a hiatus for unsuccessful and low-ranked nominations
2. Provide feedback to low-ranked nominations
3. Introduce an "*expedited review*" for nominees ranked in the top and bottom of the Society/Technical Council rankings.

The supporting rationale for the above proposals is based on the extensive analysis on nomination and elevation data reported in §7, where the analyses below are reported:

- Analysis of efficacy and fairness of hiatus-based policies
- Analysis of the influence of the S/TC ranking on the final IEEE ranking
- Analysis of the elevation probability as a function of S/TC ranking
- Analysis on the elevation probability of specific categories of Nominees

The above studies bring new insight into the problem of workload reduction, and also confirm or dispel several "myths" about the Fellow evaluation process.

Item #2 – Reforming the IEEE FC governance framework

A variety of challenges make it difficult for the IEEE FC to implement changes in a timely and efficient manner. To complicate things further, several details like the scoring procedure are specified in the IEEE FC Manual, so that procedural changes adopted, for example, for coping with the growing number of Nominees require IEEE Board of Directors approval.

With the primary goal of addressing the above issues, the 2016 FSPS has asked the advice of the IEEE Governance Committee on establishing a new framework under which the IEEE FC should operate in order to achieve better operational efficiency. The FSPS has also undertaken the effort of mapping that advice to a revision of the 2015 IEEE FC Manual, while also tackling ambiguities and missing provisions in the Manual currently in force.

The FSPS proposes to revise the way the IEEE FC handles its responsibilities and day-to-day operations by clarifying in the Manual what actions or policies must be adopted with IEEE BoD approval (hence specified in the Manual) or without it (hence specified in secondary governing documents under the control of the IEEE FC). Furthermore, the revision also addresses what responsibilities are under the entire IEEE FC and what responsibilities are delegated to its (existing) standing subcommittee (Fellow Strategic Planning Subcommittee, or FSPS).

The above division of responsibilities has been codified in the following separate governing documents (in order of precedence) each with its own approval authority:

1. The Operation Manual, requiring approval of IEEE FC and IEEE BoD
2. The document "*Nomination and Evaluation Forms*", requiring approval of IEEE FC
3. Two new normative Handbooks requiring approval of IEEE FSPS and IEEE FC Chair:
    a. "Additional Requirements, Responsibilities, and Guidelines for IEEE S/TC Fellow Evaluating Committees"
    b. "Fellow Evaluation Process and Scoring"
4. A new Recommendation Guide entitled "*How to write an effective nomination*," which requires approval of the IEEE FSPS and the Chair
5. A set of informative Web Help Guides (informative) to aid in the use of the IEEE web-scoring program, maintained by the IEEE Fellow Activities Manager, and requiring approval of the IEEE FC Chair.

IEEE FC approval will be requested for the above new/revised governance documents. These documents are not included in this report and have been provided separately to the IEEE FC (see file "*Governance Files - Version FC.zip*").

Item #3 – Improving communication with S/TCs

If the workload reduction proposal in Item #1 is approved, the IEEE FC will deliberately exploit the strength of the Society/Technical Council (S/TC) Fellow Evaluating Committees (FECs): the capability of individuating the very strong and very weak Nominees. Even if the workload reduction proposal in Item #1 is not approved, it is now well known that, even in the status quo, the S/TCs exercise a good amount of influence on the choice of the very strong and very weak Nominees – e.g., see the analyses in §7.2 and §7.3. Therefore, regardless of what happens to the proposal in Item #1, the FSPS considered it very important to ensure that S/TC-FECs had:

4. Uniform and transparent practices
5. Enough rotation of FEC members, avoiding systematic bias
6. A good understanding of the tasks requested of them

The FSPS addressed the above requirements in a variety of ways, from adding to the IEEE FC Manual governance requirements common to all S/TCs, to clarifying terms limits, to clarifying in a new Handbook the evaluation tasks that S/TCs-FECs have to follow

Item #4 – Improving the quality of nominations

To address the objective of improving the quality of Fellow nominations, the FSPS crafted a new Recommendation Guide entitled: "*How to Write an Effective IEEE Fellow Nomination*." The Guide provides examples and best practices from the perspective of IEEE Judges and S/TC Evaluators. In addition to providing recommendations, this guide also includes a list of "things to avoid" when completing the nomination. It is hoped that this Guide will help with the submission of better written nominations, an indirect way of reducing the workload on Judges.

Item #5 – Increasing the pool of applicants from underrepresented demographics

The FSPS addressed the issue of increasing the nominations of underrepresented demographics, and some of initiatives undertaken this year are described in the report. Furthermore, an in-depth analysis on the nomination and elevation data of two important and underrepresented categories (female and industry nominees) was performed analyzing trends, elevation probabilities, and the potential presence of bias in the evaluation process.

Available data did not show evidence of unfairness in the Fellow process, neither between male and female nominees nor between industry and academic nominees. As far as gender, it was also found that the "elevation event" is *somewhat*[1] independent of the nominee gender and that elevations are being made proportionally to the a priori distribution of nominated men and women. Furthermore, nominees in all employment affiliation types (industry, academia, Government, other) have very similar elevation probabilities whereas Application Engineer/Practitioner and especially Educator nominees experience a much lower elevation probability when compared to Technical Leader and Research Engineer/Scientist nominees.

Industry and female nominees represent (1999-2016 temporal average) only the 26.4% and 5.7% of all nominees, respectively. In terms of trends, the trend of female nominations is positive and, in the past five years (2013-2017), the percentage of female nominees has grown

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[1] Independence between "elevation event" and gender holds well for men but somewhat looser for women as the wide yearly variability of female elevations does not allow, in certain cases, an estimate of the direct conditional elevation probability as accurate as for the male case. For more details, see §7.4.2 and §7.4.4.9.

to 7.4%. However, industry nominations are decreasing and the last 5-year average is now down to 21.3%. Finally, it is pointed out that the share of female Fellows is today only 4.5% of all Fellows, much lower than the 12.7% share of female IEEE members.

For the detailed analysis, additional results, and recommendations see §7.4.

Acknowledgement

The 2016 FSPS wishes to express its gratitude to the IEEE Fellow Activities Staff Rosann Marosy and Donna Dukes without whom a lot of the work done this year would have been impossible. Rosann and Donna were instrumental in gathering the Fellow data that enabled the in-depth analysis presented in §7, giving the "historical" perspective of the IEEE FC, and providing feedback on several of the 2016 FSPS initiatives.

5. Item #5 – Increasing the pool of applicants from underrepresented demographics (gender, region, category, etc.)

To increase the number of elevations of people from underrepresented demographics, the goal was identified to increase the number of qualified candidates in our nomination pool. The approach is to increase awareness of the Fellow process through the following activities. The FSPS has looked in depth into how two specific categories do in the Fellow nomination and elevation process: female and industrial nominees. For recommendations, see §7.4.3.

5.1 Female Nominees

A summary of activities and initiatives is given below:

- Women Nominees:
  - Advertisement in the "Women In Engineering (WIE)" newsletter, May/June 2016, see page 36 of the Newsletter
  - Article in the WIE magazine, to appear in December 2016, interviewing the IEEE FC Chair about the IEEE Fellow process.
  - A Live Web chat, to be arranged.
  - An analysis of nomination and elevation statistics for male and female nominees, as well as a breakdown of male and female nominees in terms of nomination categories and employment affiliation types, can be found in §7.4.4.8-§7.4.4.14.

The IEEE membership breakdown by gender and membership grades is shown in Table 2. Note that percentages for women and men are calculated with respect to members with self-declared gender only, while the percentage of Undeclared is calculated with respect to all members in same grade.

Table 2 – Breakdown of IEEE membership by gender and grade
(F): Females; (M): Males; (U): Undisclosed Gender. Percentages of (F) and (M) are calculated ignoring (U).

Grade	(F)%	F	(M)%	M	(U)%	(U)	Total per grade	Total% per grade
Student	30.3%	15,531	69.7%	35,716	28.5%	20,457	71,704	17.0%
Graduate Stud.	20.9%	6,493	79.1%	24,605	27.6%	11,832	42,930	10.2%
Member	8.7%	18,902	91.3%	198,103	14.1%	35,606	252,611	59.9%
Senior Member	6.4%	2,400	93.6%	35,018	3.0%	1,150	38,568	9.1%
Fellow	4.5%	339	95.5%	7,154	0.6%	49	7,542	1.8%
Associate	15.8%	996	84.2%	5,299	23.7%	1,958	8,253	2.0%
Honorary	4.3%	1	95.7%	22	28.1%	9	32	0.0%
Totals	12.7%	44,662	87.3%	305,917	16.9%	71,061	421,640	100.0%

An interest thing to note is that the percentage of female members decreases as female members move up the membership grades. This decrease is monotonic, with women being 30.3% of Student members and decreasing to 20.9% of Graduate Student members, 8.7% of Members, 6.4% of Senior Members, and finally to being only 4.5% of all Fellows. This does not happen for male members whose share of membership grows monotonically with seniority of grade.

Another interesting thing to note is that the 12.7% female membership in IEEE is actually inflated by the high number of female students (graduate and non). If we eliminate all Student Members except Graduate Student Members, then the share of women in IEEE goes down to 9.7%. If we eliminate all Student Members, then the share of women in IEEE goes down to 8.4%. This is much lower than the percentage of female engineers in the USA which a 2012 report of the U.S. Congress Joint Economic Committee (JEC) estimated to be at 14% – see the report "*STEM Education: Preparing for the Jobs of the Future*". This suggests that IEEE should be doing a better job not only in attracting female engineers but also in retaining them as they grow in their careers.

We also note that the percentage of female Senior members (6.4%) is on par with the share of female Fellow nominees in recent years (7.3%, average 2012-2016). However, outreach efforts for growing the number of qualified female nominees should be intensified anyway because the number of female Fellows is only 4.5%.

The analysis of nomination and elevation statistics has uncovered interesting results which are reported in §7.4.2. We report here the most important one: available data did not show evidence of gender-bias in Fellow elevations, although it has also shown that the yearly data variability for the female case does not allow, in certain cases, an estimate of the conditional elevation probability for women as accurate as for the male case.

Specifically:

- Averaging over 1999-2016, the direct conditional elevation probability of male (39%) and female (39.3%) nominees is extremely close to the unconditional probability of elevation (39%). This suggests that, on average, the "elevation event" for a nominee is independent of gender. However, while the 95% Confidence Interval for the male conditional elevation probability and the unconditional probability of elevation is only 2.3%, the one for the female conditional elevation probability is equal to 6.1% so that event independence may hold looser for women. This means that the difference between the male and female conditional elevation probabilities could be in the range ±8.4%.
- Averaging over 1999-2016, the reverse conditional elevation probabilities (94.1% for men and 5.9% for women) are extremely close to the a priori distribution of male (94.3%) and female nominees (5.7%). The 95% Confidence Interval for all these probabilities is around 1%, thus suggesting strong evidence for the fact that gender and elevation are independent events and that, furthermore, elevations are being made proportionally to the a priori distribution of male and female nominees.

5.2 Industrial Nominees

A summary of activities and initiatives is given below:

- An exploration of the question whether Nominees from Industry or other employment affiliation types (Academia, Government, Other) are disadvantaged or not was also performed and key findings are summarized in §7.4.1. The statistical analysis indicates that Nominees from industry actually have an average 8% higher probability of being elevated when compared to Nominees in any other employment affiliation type (Government, academia, and other). Available data did not show evidence of unfairness in the Fellow process between nominees of any employment affiliation type. On the other hand, an issue was found with Application Engineer/Practitioner and especially Educator nominees who experience a much lower elevation probability than Technical

7.4 Analysis on the elevation probability of specific categories of Nominees

There is a perception that industry Nominees have a hard time becoming IEEE Fellows (harder than academics) and that many more academics than industry members are getting elevated. This analysis tries to shed some light on this matter and also tries to answer a more general question: is there any category of members that has a better elevation probability than others?

In the analysis, membership has been segmented in order to categorize members in two ways:

- By employment affiliation type (EAT): Industry (Ind.), Education/Academics (Acad.), Government (Govt.), Other
- By nomination category (NC): Application Engineer/Practitioner (AE/P), Educator (EDU), Research Engineer/Scientist (RE/S), and Technical Leader (TL).
- By gender – note that the information on the Fellow nominee gender is taken from the IEEE membership database, not the Fellow Nomination form, and it is an optional field. Thus, we here analyze the sets of *self-declared* men and *self-declared* women.

The analysis in §7.4.4 is based on IEEE data only. A similar analysis was performed on the data of four Societies and is reported in §7.4.5. The Societies are: Computer (COMP), ComSoc (COMM), Power & Energy (PES), and Signal Processing (SPS).

Available data for this study is from 1999 to 2016 for IEEE data segmented by EAT, 2007-2016 for IEEE data segmented by NC, and 2012-2016 for the considered Societies. Additional data for the 2017 nominations was also used. Note that nominations and elevations of female nominees are available since 1999; however, data on female nominees segmented by EAT and NC is available only since 2012.

It is the first-time that such an extensive analysis is reported. Some limited analysis was done by the 2009 FSPS, see Key Finding #3.

7.4.1 Key findings with respect to the nominee's EAT and NC

The following key findings are noteworthy:

1. The number of Nominees employed in academia has more than doubled (+108%) in 1999-2016, while the number of industry Nominees has decreased around 8% over the same period. Today, academics account for around 71% of all nominations while Nominees from industry account for around 21%, and Government plus Other for around 8%. This means that academic Nominees constitute a much bigger talent pool than any other type of Nominees and thus offers a bigger pool of talented candidates to choose from when considering elevation. Furthermore, today 78% of Nominees are nominated in the RE/S category, 11% as TLs, 7% as AE/P, and 4% as EDU.
2. When segmenting data based on NC, we find strong differences in elevation probability. The analysis shows that members nominated in the RE/S category have an elevation probability (averaged over time) that is +21% higher than the one of all other NCs combined. Similarly, for TLs we have -3%, for AE/P -15%, and for EDU -36%. In absolute numbers, the average elevation probabilities we found are: for RE/S it is 38.7%, for TL it is 36.1%, for AE/P it is 31.8%, and for EDU it is 24.5%. Interestingly, the categories with the lowest elevation probabilities are not constituted only of industry members:
    a. 95% of EDU Nominees are from academia (on the average).

   b. 25% of AE/P Nominees are from the academia, Government, and Other while 75% is from industry (on the average). However, note that in 2016, industry Nominees in AE/P were only 60%.
3. The perception that industry members have lower elevation probability when compared to academics is <u>not</u> substantiated by facts. The opposite is actually true: industry people have a probability (averaged over time) of being elevated that is 8% higher than the elevation probability of Nominees in all other EATs combined. On the other hand, academics have a probability (averaged over time) of being elevated that is 5% lower when compared to all other EATs combined. Overall, elevation probabilities of members segmented by EATs are rather comparable: Industry: 41.3%, Other 39.6%, Government 39.5%, Academics 38.4% – this is very different from the NC case where we found that the average elevation probabilities of EDU and AE/P Nominees were substantially lower than the ones of RE/S and TL Nominees. The 2009 FSPS had looked at how industry Nominees were treated and reached the following conclusion: "*So, the issue it seems is not the way in which [industry] nominations are treated, but rather the number of nominations received, and the challenge is to increase the number of nominations in the category of Application Engineer/Practitioner*" [2009 FSPS]. The 2009 FSPS analysis looked only at two years of data (2008-2009) and, at that time, did not investigate disparities related to the NCs which have been addressed in this report (see Key Finding # 2).
4. Data excludes the presence of any "academia vs industry" large difference in terms of elevation probability, and perception to the contrary may be fueled by the fact that industry Nominees are in shorter supply than the academic one. A strong disparity in elevation probabilities has actually been observed for the EDU and AE/P categories, and especially for EDU which is strongly dominated by academics. This was also noted by the 2010 FSPS, looking at data from 2008-2010.
5. The success rates across categories differ strongly in the four S/TCs considered here (Computer, ComSoc, Signal Processing, Power & Energy). The 2010 FSPS noted the same in all S/TCs when considering data in 2008-2010.
6. Possible explanations for the lower elevation probabilities of EDU and AE/P:
   a. Verifiable evidence and its impact are objectively more difficult to assess for AE/P and EDU than for RE/S.
   b. The talent pool of academics among the Nominees is much larger than the one of any other EAT and the vast majority of Nominees are in the RE/S category, which is easiest to evaluate in terms of verifiable evidence and impact. This contributes to the erroneous perception that academics and researchers are favored. In reality, most academics and researchers are nominated as RE/S which is perhaps the easiest category to evaluate in terms of impact because the natural goal of research is to produce public information with wide dissemination and its aim for impact has been the object of scrutiny and quantitative assessment by government and private entities for generations. Furthermore, academics are simply more numerous than any other category and thus there are more good people to choose from.
7. It can be helpful to also consider externalities contributing to low percentages of nominated industry members and low nominations rates in AE/P and TL may be. What follows is not really a "Key Finding" but a set of well-educated opinions:

a. Many industry members are probably not engaged in activities for which Fellowship is an appropriate recognition. For achievements in such activities, there are other awards, medals, and various recognition instituted by the IEEE to recognize and honor such types of accomplishments.
b. The Fellow grade is likely more important to academics. It is very well possible that one of the reasons fewer industry candidates are nominated is that their company gives them no or few incentives to seek a nomination, that elevation to Fellow is not "rewarded" by their managers, and spending time and effort to go through the process perhaps even frowned upon.
c. Corporate R&D has changed a lot since the golden years of a couple of generations ago, and perhaps this has also to do with the fact that there many more incentives and pressure for delivering short term results rather than investing in long term R&D, e.g. the financial industry demands quarterly estimates, contract to executives have short-medium duration and with incentives on short terms stock appreciation.
d. In support of the previous two points, we would like to cite a 2006 study done by Robert Lucky and Jon Eisenberg for the USA National Academy of Engineering: Renewing U.S. Telecommunications Research. The study showed a sharp change in publication trends in telecom research between 1970 and 2005. In 1970, about 80% of papers published in the IEEE Transactions on Communications were authored by industry people, but in 2004 that number declined to a 15% (USA industry alone went from 70% down to 7%). Similar trends hold also for conference papers (e.g., ICC and Globecom). The reduced contributions from industry have been partially offset by an increase in the number of academic papers – both from U.S. and foreign universities.

7.4.2 Key findings with respect to the nominee's gender

The following key findings are noteworthy:

1. The 1999-2017 average number of female nominees is 5.8% of all nominations, although in the five most recent years it has grown to an average of 7.3%. Although nominations in the last decade have been in line with the fraction of female Senior Members in IEEE (6.4% of all Senior members), earlier nominations were much fewer and in some years could even be as low as zero.
2. Female fellows are 4.5% of all Fellows, which is well below the 12.7% of women in IEEE (counting all membership grades).
3. Average (2012-2017) age of female nominees is 53.9 versus 56.3 for men. For female and male nominees passed in 2012-2016 the average age is 53.5 and 56.3, respectively.
4. Available data did not show evidence of gender-bias in Fellow elevations, although it has also shown that the yearly data variability for the female case does not allow, in certain cases, an estimate of the conditional elevation probability for women as accurate as for the male case. Specifically:
    - Averaging over 1999-2016, the direct conditional elevation probability of male (39%) and female (39.3%) nominees is extremely close to the unconditional probability of elevation (39%). This suggests that, on average, the "elevation event" for a nominee is independent of gender. However, while the 95% Confidence Interval for the male conditional elevation probability and the unconditional probability of elevation is only 2.3%, the one for the female

conditional elevation probability is equal to 6.1% so that even independence may hold somewhat looser for women. The difference between the male and female conditional elevation probabilities could be in the range ±8.4%.

- Averaging over 1999-2016, the reverse conditional elevation probabilities (94.1% for men and 5.9% for women) are extremely close to the a priori distribution of male (94.3%) and female nominees (5.7%). The 95% Confidence Interval for all these probabilities is around 1%, thus suggesting strong evidence for the fact that the gender and elevation are independent events and that elevations are being made proportionally to the a priori distribution of male and female nominees.

5. By far, female RE/S nominees are the largest group with an average of 50.3 nominees per year. Female AE/P, EDU, and TL nominees only have a (2012-2017) average of 2.8, 3.3, and 4.8 nominees per year.
6. By far, female academic nominees are the largest group with an average of 46.7 nominees per year. Women in Other, Government, and industry have an (2012-2017) average of 0.8, 5.5, and 8.3 nominees per year.
7. Differently from the male case, AE/P, EDU, and RE/S are dominated by nominees in a single EAT: industry, academics (100%), and again academics (82.1%), respectively. Female TL nominees are equally distributed across academia, Government, and industry.

7.4.3 Recommendations

The following recommendations to the IEEE FC are made:

1. Although we have ascertained that the average elevation probability of industry members is better that the one of academics, the number of industry Nominees has been declining over the past 18 years. There can be many reasons for this, and the available data does not allow pinpointing the root cause. However, the IEEE FC should intensify outreach initiatives (e.g., via the Publicity Plan) to stimulate nominations from qualified industry members. This will cause the small supply of AE/P and TL to increase, which will grow the pool of good people to choose from, and finally raise their elevation probabilities.
2. One of the identified possible causes for the lower elevation probability of EDU and AE/P Nominees compared to RE/S ones is the objective difficulty of (a) making the case in terms of verifiable evidence and its impact and (b) assessing the evidence presented. The IEEE FC should undertake the following actions to address these issues:
   a. Increase the quality of nominations, Reference, and endorsements by providing clear guidelines and recommendations to all the participants in the Fellow process. This will help improving all nominations, and thus also the AE/P and EDU ones.
   b. Improve the orientations courses for Society Evaluators and IEEE Judges, and specifically address the issue of how to weigh the presented evidence and how to assess it in a way that is meaningful to the specific NC of the Nominee.
3. Outreach initiatives to stimulate the number of qualified female Nominees should continue and be intensified in order to increase the number of female nominees and also stabilize the trend of elevations which today continues to exhibit high variability between years. Additional efforts should be directed at increasing the diversity of nominees in terms of EAT as today the vast majority of female nominees is from academia.

4. The Fellow Committee should have diverse membership in terms of gender and other underrepresented demographics. Fellow Committee members should also actively solicit nominations for qualified people that are underrepresented in the Fellows category, and especially women who today are only 4.5% of all Fellows – largely below the 12.7% of female members in the IEEE.

7.4.4 Analysis of IEEE data

The analysis is organized in several sections, each of which focuses on different aspects and subsets of the data:

1. Data segmented by NCs
    a. Trends of elevations and nominations over time
    b. A breakdown of EATss in terms of NCs
    c. Elevation probabilities segmenting data by NC
2. Data segmented by EATs
    a. Trends of elevations and nominations over time
    b. A breakdown of NCs in terms of EATs
    c. Elevation probabilities segmenting data by EAT
3. Data segmented by both EATs and NCs
4. Data segmented by Nominee's gender
    a. Trends of elevations and nominations over time, for female Nominees only
    b. Elevation probabilities for female Nominees only
    c. A breakdown of EATs in terms of NCs, for female Nominees only
    d. A breakdown of NCs in terms of EATs, for female Nominees only
    e. Elevation probabilities segmenting data by NC, for female Nominees only
    f. Elevation probabilities segmenting data by EAT, for female Nominees only
    g. Elevation probabilities segmenting data by EAT *and* NC , for female Nominees only
5. An interesting property of the data

When relevant, the 95% Confidence Interval (95%-CI) in the estimate of the temporal mean of the conditional elevation probability will also be reported.

7.4.4.1 Nomination and elevation trends, by nomination category

Let us now look at the data by segmenting it in terms of NCs. This is shown in Figure 4, where it is easy to confirm that the RE/S Nominees continue to grow and they are by far the single dominating NC of all both in terms of nominations and elevations. The percentage of nominations of each NC will be shown later, see Table 27.

In Figure 5, we can appreciate better the trend of AE/P, EDU, and TL. Compared to RE/S, the number of Nominees in these three NCs has remained pretty constant: EDU nominations decreased around 10% and AE/P nominations increased around 10%. On the other hand, while elevations of AE/P and TL Nominees have grown around 10%, the elevations of EDU Nominees have decreased as much as 50% over the past decade.

Table 42 – Conditional probabilities of elevation $Pr\{P|EAT\ and\ NC\}$, $min|mean|max$ for 2007-2016. The last column on the right contains $Pr\{P|EAT\}$ (see Table 63, left side) while the bottom row contains $Pr\{P|NC\}$ (see Table 63, right side), both averaged over 2007-2016.

	AE/P	EDU	TL	RE/S	
Ind	20.0%|32.5%|42.6%	0.0%|28.6%|100%	31.0%|39.0%|46.3%	28.9%|44.2%|58.2%	39.7%
Acad	0.0%|31.9%|66.7%	17.8%|25.2%|42.4%	20.0%|31.6%|64.7%	32.7%37.5%|43.3%	36.4%
Govt	0.0%|22.3%|50.0%	0.0%	7.1%|32.7%|53.8%	30.3%|41.8%|56.5%	37.2%
Other	0.0%|49.2%|50.0%	0.0%	0.0%|33.3%|75.9%	11.1%|39.9%|66.7%	37.9%
	31.8%	24.5%	36.1%	38.7%	

The table shows several interesting things:

- None of Government and Other members nominated in EDU have ever been elevated
- Some subsets of Nominees have conditional elevation probabilities that have very wide ranges, such as Industry members nominated as EDU, Academics nominated as AE/P, Government and Others nominated as AE/P, etc.
- Some subsets of Nominees have conditional elevation probabilities that have narrower ranges, such as Industry members nominated as AE/P or TL, Academics nominated as RE/S, etc.
- Industry Nominees have the highest average conditional elevation probability across every EAT and every NC.

7.4.4.8 Nomination and elevation trends, by nominee's gender only

The Nominee's gender is not included in the Nomination form and it is taken from the IEEE membership database, where it is an optional field. IEEE has data on male/female nominees as well as nominees of undisclosed gender since 2012, but we have no information on nominees of undisclosed gender between 1999 and 2011. In our analysis, we will approximate the set of male nominees with the set of *all* nominees minus female nominees in years 1999-2011, thus assuming that prior to 2012 there were no nominees of undisclosed gender. As shown in Table 2, the percentage of members of undisclosed gender for the two membership grades of interest to the Fellow process (Senior and Fellow) is very low. This makes plausible approximating the number of nominees of undisclosed gender to zero when data is not available.

Figure 11 shows the nomination and elevation trends for all Nominees and also for male nominees. We can see that the trend of male nominees closely follows the trend of all nominees, if not for the growing (yet small) gap due to the increasing number of female nominees over time.

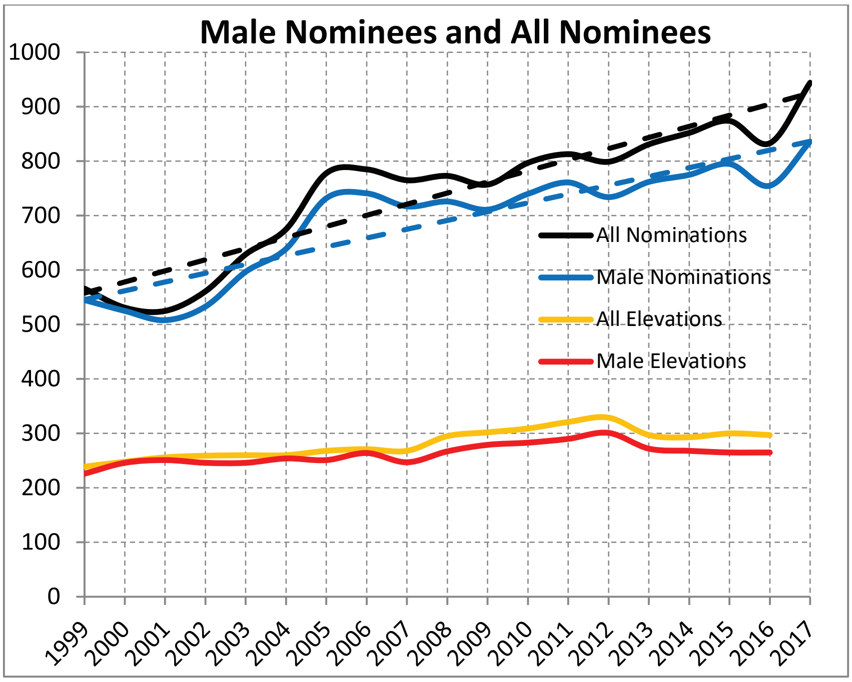

Figure 11: Nomination and elevations trends of male nominees vis-à-vis *all* nominees.

The trend for female nominees is shown in Figure 12. We note a sustained growth in nominations from 21 in 1999 to 80 in 2017 (+281%) and a corresponding growth in elevations, from 13 in 1999 to 23 in 2016 (+77%), which however is around four times slower than the growth in nominations.

For the case of female elevations, the IEEE has data that goes back to the mid 60s. This data is plotted in Figure 13 which shows that the number of elevations of female nominees did not really start to grow until the early 90s. Furthermore, it is interesting to note that the number of female elevations has never been smooth and continues to exhibit a high variability over time also in recent years. This variability of elevations coupled with the small sample size will cause wide variations in the conditional elevation probability and, as a consequence, a widening in the 95% Confidence Interval (95%-CI) with respect to the male case.

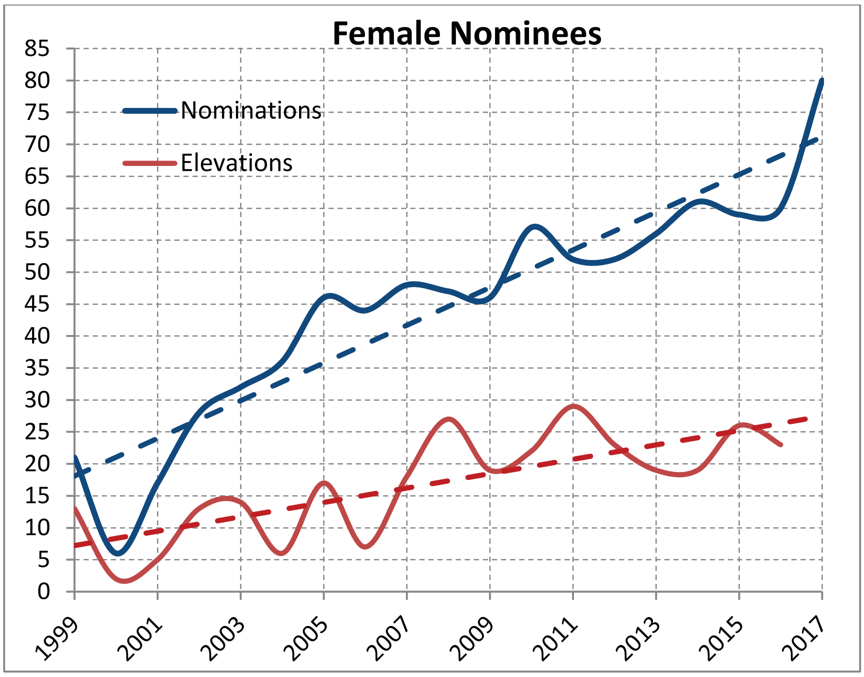

Figure 12: Nomination and elevations trends of female nominees.

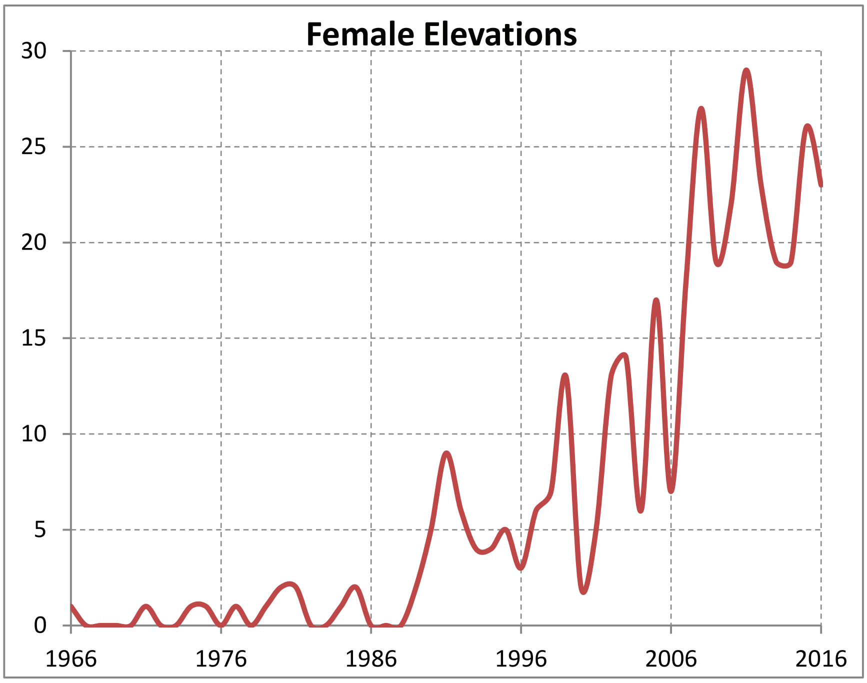

Figure 13: Historical plot of the number of elevations of female nominees.

7.4.4.9 Elevation probabilities segmenting by nominee's gender only

The available data is shown in Table 43. All the results discussed in this section can be obtained starting from this table.

Table 43 – Nominations and elevations by gender.

	Unsuccessful Nominations			Successful Nominations			
Class of	Males	Females	Total F	Males	Females	Total P	Total F&P
1999	319	8	327	226	13	239	566
2000	279	4	283	246	2	248	531
2001	257	12	269	251	5	256	525
2002	287	15	302	246	13	259	561
2003	351	18	369	246	14	260	629
2004	385	30	415	254	6	260	675
2005	481	29	510	251	17	268	778
2006	477	37	514	264	7	271	785
2007	470	30	500	247	18	265	765
2008	459	20	479	267	27	294	773
2009	432	27	459	279	19	298	757
2010	457	35	492	283	22	305	797
2011	471	23	494	290	29	319	813
2012	433	29	462	301	23	324	786
2013	490	37	527	272	19	291	818
2014	507	42	549	268	19	287	836
2015	530	33	563	265	26	291	854
2016	490	37	527	265	23	288	815
Mean	420.8	25.9	446.7	262.3	16.8	279.1	725.8

Following the same methodology of §7.4.4.3 and §7.4.4.6, we obtain the marginal probabilities of Table 44 and the direct and reverse conditional probabilities of Table 45.

Table 44 – Marginal probabilities of male and female nominees, and successful P(P) and unsuccessful P(F) nominations. The last two-rows show column-wise (temporal) averages and the 95%-CI of the average, respectively.

Class of	P(Male)	P(Female)	P(F)	P(P)
1999	96.3%	3.7%	57.8%	42.2%
2000	98.9%	1.1%	53.3%	46.7%
2001	96.8%	3.2%	51.2%	48.8%
2002	95.0%	5.0%	53.8%	46.2%
2003	94.9%	5.1%	58.7%	41.3%
2004	94.7%	5.3%	61.5%	38.5%
2005	94.1%	5.9%	65.6%	34.4%

Class of	P(Male)	P(Female)	P(F)	P(P)
2006	94.4%	5.6%	65.5%	34.5%
2007	93.7%	6.3%	65.4%	34.6%
2008	93.9%	6.1%	62.0%	38.0%
2009	93.9%	6.1%	60.6%	39.4%
2010	92.8%	7.2%	61.7%	38.3%
2011	93.6%	6.4%	60.8%	39.2%
2012	93.4%	6.6%	58.8%	41.2%
2013	93.2%	6.8%	64.4%	35.6%
2014	92.7%	7.3%	65.7%	34.3%
2015	93.1%	6.9%	65.9%	34.1%
2016	92.6%	7.4%	64.7%	35.3%
Mean	**94.3%**	**5.7%**	**61.0%**	**39.0%**
95%-CI	**±0.8%**	**±0.8%**	**±2.3%**	**±2.3%**

We point out that the P(F) and P(P) in the above table are very close but not the same as the one shown in Table 37. The reason they are not the same is that the nominees of undeclared gender have been excluded in the above table while all nominees (included the ones with an undisclosed gender) were accounted for in Table 37.

Table 45 – Direct and reverse conditional elevation probabilities, when partitioning by NC (women only). The last two-rows show column-wise (temporal) averages and the 95%-CI of the average, respectively.

Class of	P(P|Male)	P(P|Female)	P(Male|P)	P(Female|P)
1999	41.5%	61.9%	94.6%	5.4%
2000	46.9%	33.3%	99.2%	0.8%
2001	49.4%	29.4%	98.0%	2.0%
2002	46.2%	46.4%	95.0%	5.0%
2003	41.2%	43.8%	94.6%	5.4%
2004	39.7%	16.7%	97.7%	2.3%
2005	34.3%	37.0%	93.7%	6.3%
2006	35.6%	15.9%	97.4%	2.6%
2007	34.4%	37.5%	93.2%	6.8%
2008	36.8%	57.4%	90.8%	9.2%
2009	39.2%	41.3%	93.6%	6.4%
2010	38.2%	38.6%	92.8%	7.2%
2011	38.1%	55.8%	90.9%	9.1%
2012	41.0%	44.2%	92.9%	7.1%
2013	35.7%	33.9%	93.5%	6.5%
2014	34.6%	31.1%	93.4%	6.6%
2015	33.3%	44.1%	91.1%	8.9%
2016	35.1%	38.3%	92.0%	8.0%

Class of	P(P|Male)	P(P|Female)	P(Male|P)	P(Female|P)
Mean	**39.0%**	**39.3%**	**94.1%**	**5.9%**
95-CI%	**±2.3%**	**±6.1%**	**±1.2%**	**±1.2%**

On the average, the conditional elevation probability of male and female nominees is almost the same. Furthermore, the probability of finding a male or a female among the elevated nominees is very close to the a priori unconditional probabilities of having a male or female nominee, thus suggesting that elevations are being made proportionally to the a priori distribution of men and women among the nominated population.

The average (temporal) elevation probability for male nominees is reasonably accurate and has been calculated to be equal to 39% with a 95% Confidence Interval (CI) of ±2.3%. The average (temporal) elevation probability for female nominees has been calculated to be equal to 39.3% but is affected by a much larger CI equal to 6.1%. This higher CI is due to the high variability of the elevation probability over time.

The metric "edge" η as defined in §7.4.4.3 boils down, in this case, to the ratio of the probabilities of the two left-most columns of Table 45 minus 1. Edge is shown in Table 46while a plot of edge is also shown in Figure 14.

Table 46 – The edge η for male and female nominees. The last two-rows show column-wise (temporal) averages and the 95%-CI of the average, respectively.

EDGE	Male	Female
1999	-0.33	0.49
2000	0.41	-0.29
2001	0.68	-0.40
2002	-0.01	0.01
2003	-0.06	0.06
2004	1.38	-0.58
2005	-0.07	0.08
2006	1.24	-0.55
2007	-0.08	0.09
2008	-0.36	0.56
2009	-0.05	0.05
2010	-0.01	0.01
2011	-0.32	0.46
2012	-0.07	0.08
2013	0.05	-0.05
2014	0.11	-0.10
2015	-0.24	0.32
2016	-0.08	0.09
Mean	**0.12**	**0.02**
95%-CI	**±0.25**	**±0.16**

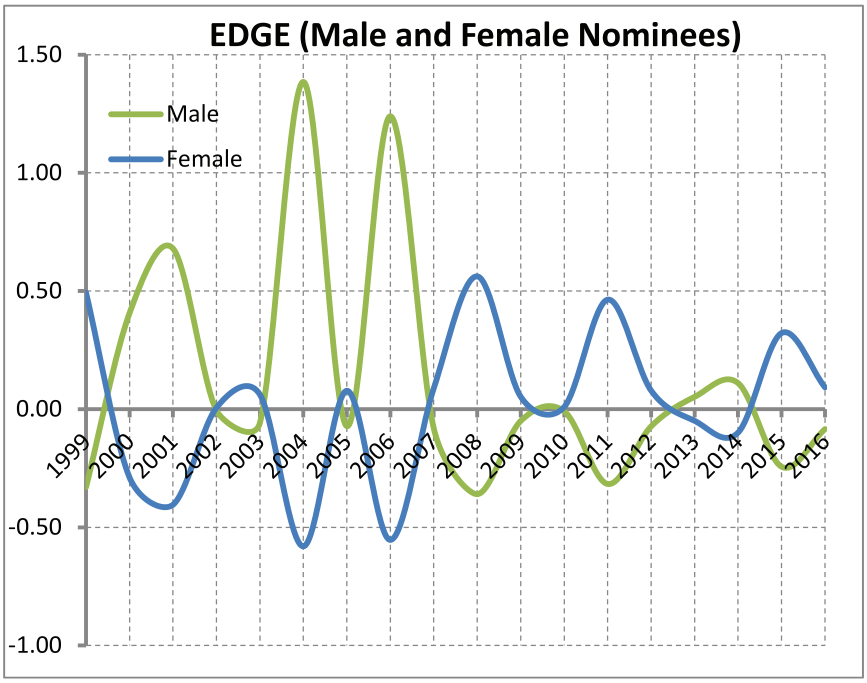

Figure 14: Plot of "edge" metric for male and female nominees.

The analysis of edge confirms that, despite wide yearly variations exemplified in the oscillatory behavior, the two categories of male and female nominees have similar average conditional elevation probability, with an historical higher edge for men. However, in recent years, the edge of women has increased and became larger than the one of men which actually became negative. For example, averaging over the past 10 years yields η=-0.11 for men and η=0.15 for women; averaging over the past 5 years yields η=-0.05 for men and η=0.07 for women. It is also noteworthy that the yearly variations of edge seem to be decreasing in recent times.

7.4.4.10 Breakdown of employment affiliation types of female nominees by nomination category

The breakdown is shown in the next four tables, from Table 47 to Table 50. Given the small number of female nominees in some EAT/NC as well as the availability of only 5 samples (years), the averages reported for non-academics must be taken with a grain of salt.

Table 47 – Composition of Industry Nominees by NC (female only).

Ind	AE/P	EDU	TL	RE/S
2012	12.5%	0.0%	12.5%	75.0%
2013	14.3%	0.0%	28.6%	57.1%
2014	50.0%	0.0%	0.0%	50.0%
2015	33.3%	0.0%	22.2%	44.4%
2016	28.6%	0.0%	14.3%	57.1%

Ind	AE/P	EDU	TL	RE/S
2017	23.1%	0.0%	23.1%	53.8%
Mean	**27.0%**	**0.0%**	**16.8%**	**56.3%**

Table 48 – Composition of Academic Nominees by NC (female only).

Acad	AE/P	EDU	TL	RE/S
2012	0.0%	5.1%	5.1%	89.7%
2013	2.3%	11.4%	2.3%	84.1%
2014	0.0%	6.0%	2.0%	92.0%
2015	0.0%	11.4%	0.0%	88.6%
2016	2.3%	4.7%	4.7%	88.4%
2017	1.7%	5.0%	5.0%	88.3%
Mean	**1.0%**	**7.3%**	**3.2%**	**88.5%**

Table 49 – Composition of Government Nominees by NC (female only).

Gov	AE/P	EDU	TL	RE/S
2012	0.0%	0.0%	60.0%	40.0%
2013	0.0%	0.0%	25.0%	75.0%
2014	0.0%	0.0%	20.0%	80.0%
2015	0.0%	0.0%	20.0%	80.0%
2016	0.0%	0.0%	28.6%	71.4%
2017	14.3%	0.0%	14.3%	71.4%
Mean	**2.4%**	**0.0%**	**28.0%**	**69.6%**

Table 50 – Composition of Other Nominees by NC (female only).

Other	AE/P	EDU	TL	RE/S
2012	N/A	N/A	N/A	N/A
2013	0.0%	0.0%	100.0%	0.0%
2014	N/A	N/A	N/A	N/A
2015	0.0%	0.0%	100.0%	0.0%
2016	0.0%	0.0%	0.0%	100.0%
2017	N/A	N/A	N/A	N/A
Mean	**0.0%**	**0.0%**	**66.7%**	**33.3%**

Summarizing the female case (for the all/male case, see §7.4.4.2):

- Similarly to the male case, at least half of industry female Nominees are in RE/S and this holds through the years as well. The remaining half splits between AE/P and TL, but not equally as for the male case. The 27% of industry women are nominated as AE/P and only 17% as TLs. There has not been any EDU nomination for industry women since 2012.

- Similarly to the male case, the vast majority of academic female Nominees is and has always been in RE/S (88%).
- Similarly to the male case, around 2/3 of Government female nominees are in RE/S (70%) and about 1/3 is in TL (28%). However, we note that in 2017 there has been a great jump of nominations in AE/P at the expense of TL.
- Differently to the male case, 2/3 of Other female nominees is in TL and 1/3 in RE/S. However, the number of Other female nominees is too small to draw any firm conclusion (only 5 nominations were submitted in 2012-2017).

7.4.4.11 Breakdown of nomination categories of female nominees by employment affiliation type

The breakdown is shown in the next four tables, from Table 51 to Table 54. Given the small number of female nominees in some EAT/NC as well as the availability of only 5 samples (years), the averages reported for non-RE/S categories must be taken with a grain of salt.

Table 51 – Composition of AE/P Nominees by EAT (female only).

AE/P	Acad	Gov	Industry	Other
2012	0.0%	0.0%	100.0%	0.0%
2013	50.0%	0.0%	50.0%	0.0%
2014	0.0%	0.0%	100.0%	0.0%
2015	0.0%	0.0%	100.0%	0.0%
2016	33.3%	0.0%	66.7%	0.0%
2017	20.0%	20.0%	60.0%	0.0%
Mean	**17.2%**	**3.3%**	**79.4%**	**0.0%**

Table 52 – Composition of EDU Nominees by EAT (female only).

EDU	Acad	Gov	Industry	Other
2012	100.0%	0.0%	0.0%	0.0%
2013	100.0%	0.0%	0.0%	0.0%
2014	100.0%	0.0%	0.0%	0.0%
2015	100.0%	0.0%	0.0%	0.0%
2016	100.0%	0.0%	0.0%	0.0%
2017	100.0%	0.0%	0.0%	0.0%
Mean	**100.0%**	**0.0%**	**0.0%**	**0.0%**

Table 53 – Composition of TL Nominees by EAT (female only).

TL	Acad	Gov	Industry	Other
2012	33.3%	50.0%	16.7%	0.0%

TL	Acad	Gov	Industry	Other
2013	20.0%	20.0%	40.0%	20.0%
2014	50.0%	50.0%	0.0%	0.0%
2015	0.0%	25.0%	50.0%	25.0%
2016	40.0%	40.0%	20.0%	0.0%
2017	42.9%	14.3%	42.9%	0.0%
Mean	**31.0%**	**33.2%**	**28.3%**	**7.5%**

Table 54 – Composition of RE/S Nominees by NC (female only).

RE/S	Acad	Gov	Industry	Other
2012	81.4%	4.7%	14.0%	0.0%
2013	84.1%	6.8%	9.1%	0.0%
2014	86.8%	7.5%	5.7%	0.0%
2015	83.0%	8.5%	8.5%	0.0%
2016	76.0%	10.0%	8.0%	6.0%
2017	81.5%	7.7%	10.8%	0.0%
Mean	**82.1%**	**7.5%**	**9.3%**	**1.0%**

Summarizing the female case (for the all/male case, see §7.4.4.5):

- Similarly to the male case, the vast majority of AE/P female Nominees have traditionally been from the industry (79.4%) with academics being the second largest group (17.2%). However, we note that in 2017 Government female Nominees in AE/P jumped from zero to 20% mostly at the expense of Academics.
- All EDU female Nominees are solely from academia in 2012-2017. For the male case, EDU nominees from academia were 95.3%.
- Differently from the male case where the TL dominant group was from industry nominees, female TL nominees are uniformly distributed across academics, Government, and industry. However, a dip of female nominees from Government in 2017 has left academics and industry female nominees equally split at around 40%.
- Similarly to the male case, data has been rather stable in the past decade and academics constitute the largest group at 82.1%, followed by industry and government Nominees at 9.3% and 7.5%, respectively.

7.4.4.12 Elevation probabilities segmenting data by nomination categories (female only)

The available data is shown in Table 55. All the results discussed in this section can be obtained starting from this table. Since non-RE/S nominees are very few and only five samples (years) are available, the average probabilities for the non-RE/S case must be taken with a grain of salt.

Table 55 – Nominations and elevations by NC (female only).

	Nominations					Elevations				
Class	AE/P	EDU	TL	RE/S	Total	AE/P	EDU	TL	RE/S	Total
2012	1	2	6	43	52	0	1	1	21	23
2013	2	5	5	44	56	0	2	1	16	19
2014	3	3	2	53	61	2	1	0	16	19
2015	3	5	4	47	59	2	1	0	23	26
2016	3	2	5	50	60	0	2	2	19	23
Mean	2.4	3.4	4.4	47.4	57.6	0.8	1.4	0.8	19.0	22.0

Following the same methodology of §7.4.4.3 and §7.4.4.6, we obtain the marginal probabilities of Table 56 and the direct and reverse conditional probabilities of Table 57.

Table 56 – Marginal probabilities of successful and unsuccessful nominations (female only), when partitioning by NC. The last two-rows show column-wise (temporal) averages and the 95%-CI of the average, respectively.

Class	P(F)	P(P)	P(AEP)	P(EDU)	P(TL)	P(RES)
2012	55.8%	44.2%	1.9%	3.8%	11.5%	82.7%
2013	66.1%	33.9%	3.6%	8.9%	8.9%	78.6%
2014	68.9%	31.1%	4.9%	4.9%	3.3%	86.9%
2015	55.9%	44.1%	5.1%	8.5%	6.8%	79.7%
2016	61.7%	38.3%	5.0%	3.3%	8.3%	83.3%
Mean	61.7%	38.3%	4.1%	5.9%	7.8%	82.2%
95%-CI	±7.3%	±7.3%	±1.7%	±3.3%	±3.8%	±4.1%

It is interesting to note that the largest number of Nominees is nominated in the RE/S category, similar to the male case. The number of female nominees in other-than-RE/S NCs is much smaller and somewhat close to the male case as well.

Table 57 – Direct and reverse conditional elevation probabilities, when partitioning by NC (female only). The last two-rows show column-wise (temporal) averages and the 95%-CI of the average, respectively.

	P(P|AEP)	P(P|EDU)	P(P|TL)	P(P|RES)	P(AEP|P)	P(EDU|P)	P(TL|P)	P(RES|P)
2012	0.0%	50.0%	16.7%	48.8%	0.0%	4.3%	4.3%	91.3%
2013	0.0%	40.0%	20.0%	36.4%	0.0%	10.5%	5.3%	84.2%
2014	66.7%	33.3%	0.0%	30.2%	10.5%	5.3%	0.0%	84.2%
2015	66.7%	20.0%	0.0%	48.9%	7.7%	3.8%	0.0%	88.5%
2016	0.0%	100.0%	40.0%	38.0%	0.0%	8.7%	8.7%	82.6%
Mean	26.7%	48.7%	15.3%	40.5%	3.6%	6.5%	3.7%	86.2%
95%-CI	±45.3%	±38.1%	±20.6%	±10.2%	±6.3%	±3.6%	±4.6%	±4.5%

The 95%-CI for the direct conditional elevation probability of female nominees is much wider than for the all/male case (see Table 27) so that it is difficult to draw conclusions on it – for this reason, we skip here the analysis of the edge metric. On the other hand, the 95%-CI of the reverse conditional probabilities is smaller than the direct ones but still not small so that we can state that female nominees are elevated *somewhat* proportionally to the a priori distribution of female nominees across NCs, with the exception of TL nominees for which there are much fewer elevations than one would expect given the number of TL nominations.

7.4.4.13 Elevation probabilities segmenting data by employment affiliation type (female only)

The available data is shown in Table 58. All the results discussed in this section can be obtained starting from this table.

Table 58 – Nominations and elevations by EAT (female only).

	Nominations					Elevations				
Class	**Acad**	**Govt**	**Ind**	**Oth**	**Total**	**Acad**	**Govt**	**Ind**	**Oth**	**Total**
2012	39	5	8	0	**52**	19	1	3	0	**23**
2013	44	4	7	1	**56**	16	2	1	0	**19**
2014	50	5	6	0	**61**	15	0	4	0	**19**
2015	44	5	9	1	**59**	20	2	4	0	**26**
2016	43	7	7	3	**60**	18	3	2	0	**23**
Mean	**44**	**5.2**	**7.4**	**1.0**	**57.6**	**17.6**	**1.6**	**2.8**	**0**	**22.0**

Following the same methodology of §7.4.4.3 and §7.4.4.6, we obtain the marginal probabilities of Table 59 and the direct and reverse conditional probabilities of Table 60.

Table 59 – Marginal probabilities of successful and unsuccessful nominations (female only), when partitioning by EAT. The last row shows column-wise (temporal) averages.

Class	P(F)	P(P)	P(Acad)	P(Govt)	P(Ind)	P(Oth)
2012	**55.8%**	**44.2%**	75.0%	9.6%	15.4%	0.0%
2013	**66.1%**	**33.9%**	78.6%	7.1%	12.5%	1.8%
2014	**68.9%**	**31.1%**	82.0%	8.2%	9.8%	0.0%
2015	**55.9%**	**44.1%**	74.6%	8.5%	15.3%	1.7%
2016	**61.7%**	**38.3%**	71.7%	11.7%	11.7%	5.0%
Mean	**61.7%**	**38.3%**	**76.4%**	**9.0%**	**12.9%**	**1.7%**
95%-CI	**±7.3%**	**±7.3%**	**±4.9%**	**±2.1%**	**±3.0%**	**±2.5%**

It is interesting to note that the largest group of Nominees has become the academic one which in 2016 accounted for 71.7% of all nominations, a percentage very close to the 71.1% of the male case. Differently from the male case, there are fewer industry female Nominees and more Government female nominees.

Table 60 – Direct and reverse conditional elevation probabilities, when partitioning by EAT (women only). The last row shows column-wise (temporal) averages.

	Pr(P|Aca)	Pr(P|Gov)	Pr(P|Ind)	Pr(P|Oth)	Pr(Aca/P)	Pr(Gov/P)	Pr(Ind/P)	Pr(Oth/P)
2012	48.7%	20.0%	37.5%	N/A	82.6%	4.3%	13.0%	0.0%
2013	36.4%	50.0%	14.3%	0.0%	84.2%	10.5%	5.3%	0.0%
2014	30.0%	0.0%	66.7%	N/A	78.9%	0.0%	21.1%	0.0%
2015	45.5%	40.0%	44.4%	0.0%	76.9%	7.7%	15.4%	0.0%
2016	41.9%	42.9%	28.6%	0.0%	78.3%	13.0%	8.7%	0.0%
Mean	**40.5%**	**30.6%**	**38.3%**	**0.0%**	**80.2%**	**7.1%**	**12.7%**	**0.0%**
95%-CI	**±9.2%**	**±25.3%**	**±24.2%**	**0.0%**	**±3.8%**	**±6.4%**	**±7.6%**	**0.0%**

The 95%-CI of the conditional probabilities for non-academic female nominees is much wider than for the all/male case (see Table 38) so that it is difficult to draw conclusions on it – for this reason, we skip here the analysis of the edge metric.

7.4.4.14 Elevation probabilities segmenting data by both employment affiliation type and nomination category (female only)

In this Section, we will consider subsets of female Nominees that were nominated in a given nomination category (NC) and also have a given employment affiliation type (EAT). Available data is for year 2012-2016, and the average number of Nominees (failed and passed) segmented in both categories is shown in Table 61. Double segmentations further reduces the sample size, so the results of this section must be taken with a grain of salt.

Table 61 – Average (2012-2016) number of failed and passed Nominees categorized by both NCs and EATs (female only).

Average 2007-2016	Failed Nominees				Passed Nominees			
	AE/P	EDU	TL	RE/S	AE/P	EDU	TL	RE/S
Industry	1.2	0	1	2.4	0.8	0	0.2	1.8
Academics	0.4	2	0.8	23.2	0	1.4	0.4	15.8
Govt	0	0	1.4	2.2	0	0	0.2	1.4
Other	0	0	0.4	0.6	0	0	0	0

Calculating the conditional probabilities of elevation $Pr\{P|Gender\ and\ EAT\ and\ NC\}$ for each year, we obtain the minimum, mean, and maximum (over 2012-2016) elevation probabilities shown in Table 62.

Table 62 – Conditional probabilities of elevation $Pr\{P|Female\ and\ EAT\ and\ NC\}$, $min|mean|max$ for 2012-2016. The last column on the right contains $Pr\{P|Female\ and\ EAT\}$ (see Table 60) while the bottom row contains $Pr\{P|NC\}$ (see Table 57), both averaged over 2007-2016.

	AE/P	EDU	TL	RE/S	
Ind	0.0%|16.0%|40%	0.0%|	0.0%|12.5%|50%	20.0%|30.3%|40.0%	38.3%
Acad	0.0%	16.7%|30.7%|50.0%	0.0%|20.8%|50%	23.3%|28.9%|34.0%	40.5%
Govt	0.0%	N/A	0.0%|6.7%|33.3%	0.0%|27.0%|40.0%	30.6%
Other	0.0%	0.0%	0.0%	0.0%	0.0%
	26.7%	48.7%	15.3%	40.5%	

The table shows several interesting things:

- None of Other female nominees have ever been elevated, and no Government female nominee in EDU was ever nominated (in 2012-2016),
- The only female nominees elevated as AE/P are from industry and the only female nominees elevated in EDU are from academia.

7.4.4.15 An interesting property unveiled in the analysis

We conclude pointing out that we have uncovered an interesting property that was never noticed before. When considering all Nominees (male, female, undisclosed gender), the average probabilities of elevation conditional to the EAT of the Nominee are very close to each other and they are also very close to the average unconditional probability of being elevated (a priori information). Despite the fact that this does not hold for every individual year, on the average it does hold pretty well.

On the other hand, this does not hold true for all the average elevation probabilities conditional to the NC. In this case, we note that while it holds for TL and RE/S, the average conditional probabilities of AE/P and especially EDU strongly differ from the unconditional one. This is not surprising as AE/P and EDU were already identified in §7.4.4.3 as the categories with the lowest conditional elevation probability.

This can be seen in Table 63, where we tabulate the conditional and unconditional probabilities of successful nominations. The last "Delta" row shows the differences between the conditional probabilities and the unconditional probability of elevation. For all EATs as well as for RE/S and TL, the average conditional probabilities are all within a few percent points of the unconditional one.

Table 63 –Direct conditional and unconditional elevation probabilities.

	P(P|Aca)	P(P|Gov)	P(P|Ind)	P(P|Oth)	P(P)	P(P|AEP)	P(P|EDU)	P(P|TL)	P(P|RES)
2007	31.7%	41.5%	42.8%	37.5%	35.0%	34.1%	23.4%	29.9%	36.9%
2008	37.5%	33.3%	41.2%	35.3%	38.2%	35.7%	41.2%	40.0%	37.9%
2009	39.8%	31.3%	42.9%	33.3%	39.9%	36.5%	25.0%	41.8%	40.9%
2010	38.0%	39.5%	38.5%	56.0%	38.8%	29.0%	23.3%	33.8%	41.5%
2011	38.2%	32.7%	45.2%	41.2%	39.5%	34.8%	28.6%	30.5%	41.7%

2012	41.2%	35.2%	43.3%	41.7%	41.2%	33.3%	24.4%	35.4%	43.8%
2013	33.7%	36.9%	42.3%	27.8%	35.7%	28.1%	21.6%	38.8%	36.9%
2014	32.6%	42.6%	34.7%	68.8%	34.4%	32.9%	21.1%	42.9%	34.0%
2015	34.1%	40.4%	34.2%	23.1%	34.3%	28.6%	17.4%	30.1%	36.5%
2016	37.0%	38.2%	32.0%	14.3%	35.7%	25.0%	18.9%	38.2%	37.1%
Mean	**36.4%**	**37.2%**	**39.7%**	**37.9%**	**37.3%**	**31.8%**	**24.5%**	**36.1%**	**38.7%**
Delta	**-0.9%**	**-0.1%**	**2.4%**	**0.6%**	**0.0%**	**-5.5%**	**-12.8%**	**-1.1%**	**1.5%**

This result can be expressed mathematically as:

$$Pr\{P|Aca\} \approx Pr\{P|Gov\} \approx Pr\{P|Ind\} \approx Pr\{P|Oth\} \approx$$
$$\approx Pr\{P|RES\} \approx Pr\{P|TL\} \approx Pr\{P\},$$

The above tells us that the "*elevation*" event is statistically independent of the "*belonging to a given employment affiliation type*" event.
If these two events were independent, then it would also follow that:

$$Pr\{Aca|P\} \approx Pr\{Aca\}$$
$$Pr\{Gov|P\} \approx Pr\{Gov\}$$
$$Pr\{Ind|P\} \approx Pr\{Ind\}$$
$$Pr\{Oth|P\} \approx Pr\{Oth\}$$

If the conditional probabilities of having an elevated Nominee belonging to EAT=X is approximately equal to the unconditional probability of finding a Nominee (elevated or not) belonging to the same X, then it also means that elevations are being made proportionally to the a priori distribution of Nominees. Data confirms the above conclusion and also that the conditional probabilities of having an elevated Nominee belonging to a given NC is approximately equal to the unconditional probability of finding a Nominee (elevated or not) belonging to that NC, as shown in Table 64.

Table 64 – Reverse conditional and unconditional elevation probabilities for (a) EATs and (b) NCs.

	P(Acad/P)	P(Gov/P)	P(Ind/P)	P(Oth/P)	P(Acad)	P(Govt)	P(Ind)	P(Oth)
2007	62.3%	10.1%	26.5%	1.1%	68.8%	8.5%	21.7%	1.0%
2008	63.7%	5.8%	28.5%	2.0%	64.8%	6.6%	26.4%	2.2%
2009	67.5%	5.0%	25.8%	1.7%	67.6%	6.3%	24.0%	2.0%
2010	66.7%	5.5%	23.3%	4.5%	68.0%	5.4%	23.5%	3.1%
2011	65.7%	5.6%	26.5%	2.2%	68.0%	6.8%	23.1%	2.1%
2012	71.1%	5.8%	21.6%	1.5%	71.2%	6.8%	20.6%	1.5%
2013	64.3%	8.1%	25.9%	1.7%	68.1%	7.8%	21.9%	2.2%
2014	65.5%	7.8%	22.9%	3.8%	69.1%	6.3%	22.7%	1.9%

	P(Acad/P)	P(Gov/P)	P(Ind/P)	P(Oth/P)	P(Acad)	P(Govt)	P(Ind)	P(Oth)
2015	70.3%	7.0%	21.7%	1.0%	70.8%	5.9%	21.7%	1.5%
2016	73.7%	7.1%	18.5%	0.7%	71.1%	6.6%	20.6%	1.7%
Mean	**67.1%**	**6.8%**	**24.1%**	**2.0%**	**68.8%**	**6.7%**	**22.6%**	**1.9%**
Deltas	**-1.7%**	**0.1%**	**1.5%**	**0.1%**				

(a)

	P(AEP/P)	P(EDU/P)	P(TL/P)	P(RES/P)	P(AEP)	P(EDU)	P(TL)	P(RES)
2007	5.6%	4.1%	10.8%	79.5%	5.8%	6.1%	12.7%	75.4%
2008	6.8%	4.7%	12.2%	76.3%	7.2%	4.4%	11.6%	76.7%
2009	7.6%	3.0%	10.9%	78.5%	8.3%	4.8%	10.4%	76.5%
2010	5.8%	3.2%	8.4%	82.5%	7.8%	5.4%	9.7%	77.2%
2011	7.2%	3.1%	7.8%	81.9%	8.1%	4.3%	10.1%	77.5%
2012	4.3%	3.0%	10.3%	82.4%	5.3%	5.1%	12.0%	77.6%
2013	6.1%	2.7%	12.8%	78.5%	7.7%	4.5%	11.8%	76.1%
2014	8.5%	1.4%	11.3%	78.8%	8.9%	2.2%	9.0%	79.8%
2015	5.3%	2.7%	9.3%	82.7%	6.4%	5.3%	10.6%	77.7%
2016	4.4%	2.4%	11.4%	81.8%	6.2%	4.4%	10.7%	78.6%
Mean	**6.2%**	**3.0%**	**10.5%**	**80.3%**	**7.2%**	**4.7%**	**10.9%**	**77.3%**
Deltas	**-1.0%**	**-1.6%**	**-0.3%**	**3.0%**				

(b)

Let us now investigate if the same properties hold for the case of nominees segmented by gender. If we segment data based only on the gender of the nominee, we can combine Table 44 and Table 45 into Table 65 where we can appreciate that:

- The direct conditional elevation probability of male and female nominees is extremely close to the unconditional probability of elevation, thus suggesting that the "elevation event" for a nominee is independent of gender. We note however that the 95%-CI for the direct conditional elevation of women is substantial at 6.1% so that the claim holds more loosely for women.
- The reverse conditional elevation probabilities are extremely close to the a priori distribution of men and women, thus suggesting that elevations are being made proportionally to the a priori distribution of nominated men and women. The claim can be made with confidence as the 95%-CI for both men and women are rather small in this case.

Table 65 – Summary of direct and reverse conditional and unconditional probabilities.

Class of	P(P|Male)	P(P|Female)	P(P)	P(Male|P)	P(Male)	P(Female|P)	P(Female)
1999	41.5%	61.9%	42.2%	94.6%	96.3%	5.4%	3.7%
2000	46.9%	33.3%	46.7%	99.2%	98.9%	0.8%	1.1%
2001	49.4%	29.4%	48.8%	98.0%	96.8%	2.0%	3.2%

Class of	P(P|Male)	P(P|Female)	P(P)	P(Male|P)	P(Male)	P(Female|P)	P(Female)
2002	46.2%	46.4%	46.2%	95.0%	95.0%	5.0%	5.0%
2003	41.2%	43.8%	41.3%	94.6%	94.9%	5.4%	5.1%
2004	39.7%	16.7%	38.5%	97.7%	94.7%	2.3%	5.3%
2005	34.3%	37.0%	34.4%	93.7%	94.1%	6.3%	5.9%
2006	35.6%	15.9%	34.5%	97.4%	94.4%	2.6%	5.6%
2007	34.4%	37.5%	34.6%	93.2%	93.7%	6.8%	6.3%
2008	36.8%	57.4%	38.0%	90.8%	93.9%	9.2%	6.1%
2009	39.2%	41.3%	39.4%	93.6%	93.9%	6.4%	6.1%
2010	38.2%	38.6%	38.3%	92.8%	92.8%	7.2%	7.2%
2011	38.1%	55.8%	39.2%	90.9%	93.6%	9.1%	6.4%
2012	41.0%	44.2%	41.2%	92.9%	93.4%	7.1%	6.6%
2013	35.7%	33.9%	35.6%	93.5%	93.2%	6.5%	6.8%
2014	34.6%	31.1%	34.3%	93.4%	92.7%	6.6%	7.3%
2015	33.3%	44.1%	34.1%	91.1%	93.1%	8.9%	6.9%
2016	35.1%	38.3%	35.3%	92.0%	92.6%	8.0%	7.4%
Mean	**39.0%**	**39.3%**	**39.0%**	**94.1%**	**94.3%**	**5.9%**	**5.7%**
95%-CI	**±2.3%**	**±6.1%**	**±2.3%**	**±1.2%**	**±0.8%**	**±1.2%**	**±0.8%**

7.4.5 Analysis of S/TC data

In this section, we applied the methodology used for the analysis of the IEEE data in §7.4.4 to the following S/TCs: Computer Society (COMP), Communications Society (ComSoc), Power & Energy Society (PES), and Signal Processing Society (SPS). For the sake of brevity, however, data will be segmented in terms of EAT and only the metric EDGE (η) will be reported. This is shown in Table 66 to Table 69.

Table 66 – The edge η for all EATs, COMP data only.

COMP	Ind	Edu	Gov+Oth
2012	0.3	0.0	-0.7
2013	0.1	0.0	-0.2
2014	0.2	0.0	-0.4
2015	-0.2	0.1	0.1
2016	-0.1	0.3	-0.4
Mean	**0.07**	**0.09**	**-0.32**
STD	**0.22**	**0.14**	**0.30**

Table 67 – The edge η for all EATs, ComSoc data only.

ComSoc	Ind	Edu	Gov+Oth
2011	0.6	-0.1	-0.5
2012	-0.2	0.3	-0.4
2013	1.9	-0.5	-1.0