

Examination of Implicit Gender Biases Among Engineering Faculty when Assigning Leadership, Research, and Service Roles

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Background and Purpose

Although there exist multiple variations, in higher education it is common to find that faculty members are evaluated for their work in three principal areas: scholarship, teaching, and service. However, these areas are not necessarily held in the same regard vis-à-vis institutional or scholarly respect. Work output is most typically defined as productivity of refereed publications and grants obtained and not primarily in terms of teaching or advising students.^{1,2}

In recent years, organizations such as the National Science Foundation have promoted the connection between teaching and research, such as through the Engineering Research Centers Program. However, evidence exists that faculty who emphasize teaching and advising more than research are not viewed as role models in academia.^{3,4,5}

Further, within the category of service there exists a wide spectrum of roles, each receiving varying veneration by the higher education community. For example, passive service such as perfunctory committee membership will receive less regard than when one takes an active leadership role and serves as the leader or chairperson of groups of people.

Yet while there is general consensus that maintaining productive research activity, successful grantsmanship, and holding leadership positions are hallmarks of successful tenured and tenure-track faculty members at research institutions there exists little specific information regarding how men and women are encouraged toward these roles. Generally, it is known that prior research has indicated wide-ranging implicit and explicit biases exist regarding the association of gender with leadership and gender with scientific and engineering roles. Additionally, in higher education there is evidence that female faculty are more likely to be in teaching and advising roles than their male counterparts.^{6,7} From this literature, it is unclear if these job-sorting circumstances are more so due to assignments made by faculty administrators or if men and women are self-sorting into different duties. Interest into this issue is particularly acute in engineering where known gender differences exist in interests among students and dispositions among faculty.⁸

The purpose of this study was to examine if male and female faculty are differently encouraged toward roles of research, leadership, and working directly with students (i.e., teaching and advising).

Relevant Literature

More than 30 years ago researchers pointed to trends in how jobs were segregated by sex.⁹ This was a trend that began to undergo marked decline of separation even as early as the 1960s and 1970s. However, an asymmetrical disproportion of men-to-women has persisted in particular careers, particularly in engineering and computer science.

Earlier research also indicated that women have often been found performing the same tasks as men in a workplace, but doing so at inferior job classifications.¹⁰ In other cases, job segregation

entails men and women of equivalent rank performing different duties; this has been attributed to both worker preferences and male-dominated administrative decisions that are biased when allocating assignments and controlling employees. However, Hornsby, Benson, and Smith¹¹ found that, given identical job descriptions, people tended to rate female prison matrons higher on job evaluations than male jailers. This implies conscious thought of evaluators regarding gender identity in the context of a job performance.

In academia it has been shown that when gender stereotypes are primed (e.g., Mary is caring, Bob is assertive) that male participants rate male applicants higher than female applicants in a mock hiring exercise.¹² Related, in a study of students rating an online instructor, evaluations were higher when the instructor's identity was male as opposed to female.¹³ In a study of faculty and their perceptions of their own work, women are considerably less inclined than men to highly rate the view they believe others hold of their scholarship.¹⁴ The researchers additionally found in their study of a research university that while 90% of male faculty believe gender equity existed on campus, this was true for only 57% of the female faculty.

Particular to science and engineering, female managers in the field of high technology are more often seen as being less committed than their male counterparts.¹⁵ Gender bias among college faculty "functions like a habit as an ingrained pattern of thoughts and behaviors"¹⁶ (p. 221). These unconscious, or implicit, biases can impede careers of women faculty as they attempt to advance and contend for various career duties.¹⁷ Unconscious biases has possibly worked quite detrimentally against women in higher education where they still lag behind men in attaining full professorships and upper administrative positions.¹⁸ This may especially be the case in science and engineering where women faculty "are paid less, promoted more slowly, receive fewer honors, and are given fewer leadership positions than men"¹⁹ (p. 321).

Method

The ARSLA Survey

To address this question of job-sorting, the Assignment of Research, Service, and Leadership Activity (ARSLA) was designed. ARSLA prompts respondents to pretend they are a college of engineering administrator who is recommending five task assignments for five faculty members in a fictitious Mechanical and Manufacturing Engineering Department.

The five tasks are one research-focused position, one leadership role, and three responsibilities related to working with students or creating a new freshman engineering course that emphasizes ethics and societal values. In other words, the five tasks on ARSLA are distinctly defined as being in the categories of research, leadership, and teaching/advising:

1. Advise incoming graduate students to help them find an advisor in their research area. *[Teaching/Advising Role]*
2. Act as Department Co-Chair for the upcoming academic year with a full professor. The Department Chair will be on sabbatical. *[Leadership Role]*
3. Be the faculty sponsor for the student chapter of the Society of Manufacturing Engineers (SME). *[Teaching/Advising Role]*

4. Work with professors from the Materials Science Dept. on an NSF research project focusing on materials processing and manufacturing research (a topic of interest to all 5 of these faculty members). [*Research Role*]
5. Work with 2 other faculty members to develop a new Intro to Engineering freshmen course. Course to focus on interdisciplinary nature of engineering and emphasize ethics & societal values. [*Teaching/Advising Role*]

Respondents were also provided brief biographical information about five faculty members who have varying years of experience. All five of the bios indicate strengths in both technical and interpersonal skills.

Survey software randomly drove half of the respondents to an ARSLA showing all five faculty members with male names, while the other half of the respondents were shown a duplicate version with one exception. The single difference between the two forms of ARSLA was a name change of the faculty member with the middle level of experience from “Charlie” to “Cathy.” The “Cathy” version of the ARSLA is provided in the appendix.

The Cathy/Charlie faculty member exists in the middle among the five characters on the ARSLA, each with progressive amounts of university experience - from Adam, who is a new assistant professor to Eric, a seasoned full professor. Each of the five characters’ bios were crafted to include aspects that demonstrate their (1) technical and research competence, and (2) their relational and teaching/student focus. As an example, these two aspects are highlighted from Bob’s description below in Figure 1.

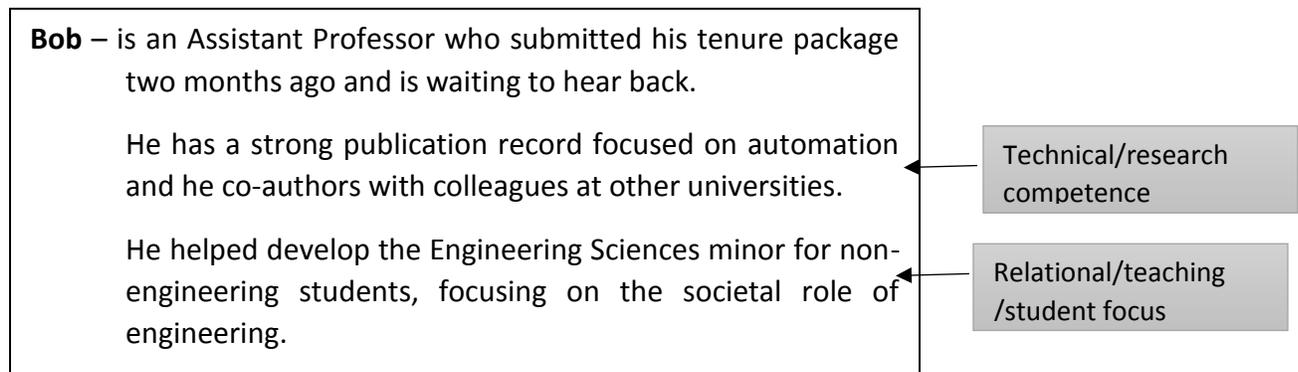


Figure 1. Example of ARSLA biographical information.

Finally, respondents were prompted to provide open responses indicating their reasons for selecting the tasks they had chosen for the five faculty members. Exploration of these qualitative data requires further analysis. For this reporting, analysis focused on the purposeful search of gender-based themes within respondents’ rationales. To accomplish this, keyword searches were conducted on terms such as *female*, *woman*, and *gender*.

Sample

A request to complete the ARSLA online was sent to engineering faculty from the 50 largest colleges of engineering in the United States. A total of 695 respondents entirely completed the ARSLA. Among the respondents, most indicated their gender: 483 male faculty members and 193 female faculty members. General information about the makeup of the sample is provided in Table 1. Respondents either currently or in the past had taught engineering courses. They identified their roles primarily as assistant, associate, and full professors; however, some respondents identified with other roles such as emeritus/emeriti and adjunct. Respondents also indicated if they either currently or in the past held an administrative position role, such as a department head, in higher education.

Table 1. Respondents' general information.

Gender	n	Avg yrs experience	Asst profs	Full profs	Black	Hispanic	Held/holds administrative role
Male	483	19.38 yrs	16.6%	20.1%	2.2%	3.3%	33.6%
Female	193	14.00	40.6	31.2	3.0	7.5	26.3

Of the 695 responses received, 360 were in response to the Charlie version of the ARSLA and 335 were in response to the Cathy version of the ARSLA. Among the respondents who completed the Charlie version of the ARSLA, 259 were male, 94 were female, and 7 did not indicate their gender. Among the respondents who completed the Cathy version of the ARSLA, 224 were male, 99 were female, and 12 did not indicate their gender.

Analysis

Analysis focused on determining how the leadership and the research positions were recommended differently, or similarly, to Cathy and to Charlie. This was accomplished by first assessing the overall probability differences between assignment of the duties between Charlie and Cathy. How male and female faculty recommended the positions to Cathy and to Charlie were then evaluated using descriptive statistics and calculating odds ratios for both the leadership and research positions.

Results

Overall Differences

Responses from individuals who completed the Charlie ARSLA and the individuals who completed the Cathy ARSLA yielded some generally expected results. First, approximately half of the groups recommended that Eric, the most senior of the faculty members, be encouraged to act as the department co-chair. Considering that chairing a department is often viewed as a leadership role in which knowledge of departmental, college, and university policies and practices are beneficial, this was not surprising. Also, in both groups Bob was overwhelmingly recommended to be the person to work on the development of the new introductory engineering course. This too was not a surprise given the design of Bob's bio. Respondents were able to read that Bob had already helped to develop a minor in Engineering Sciences that focused on the

societal role of engineering and this was extremely well aligned with the objectives of the new course to be designed. The fact that the results of Eric being recommended to act as the co-chair and Bob being recommended to work on the introductory course contribute to the reliability of the instrument.

To assess if the simple modification of the name of Charlie/Cathy prompted differences in responses, the leadership and research tasks (#2 and #4 above) were closely examined. Among the Charlie group of respondents, 8.3% recommended him to take on the role of co-chair and 25.6% indicated that he was best suited to work on the research project (Figure 2).

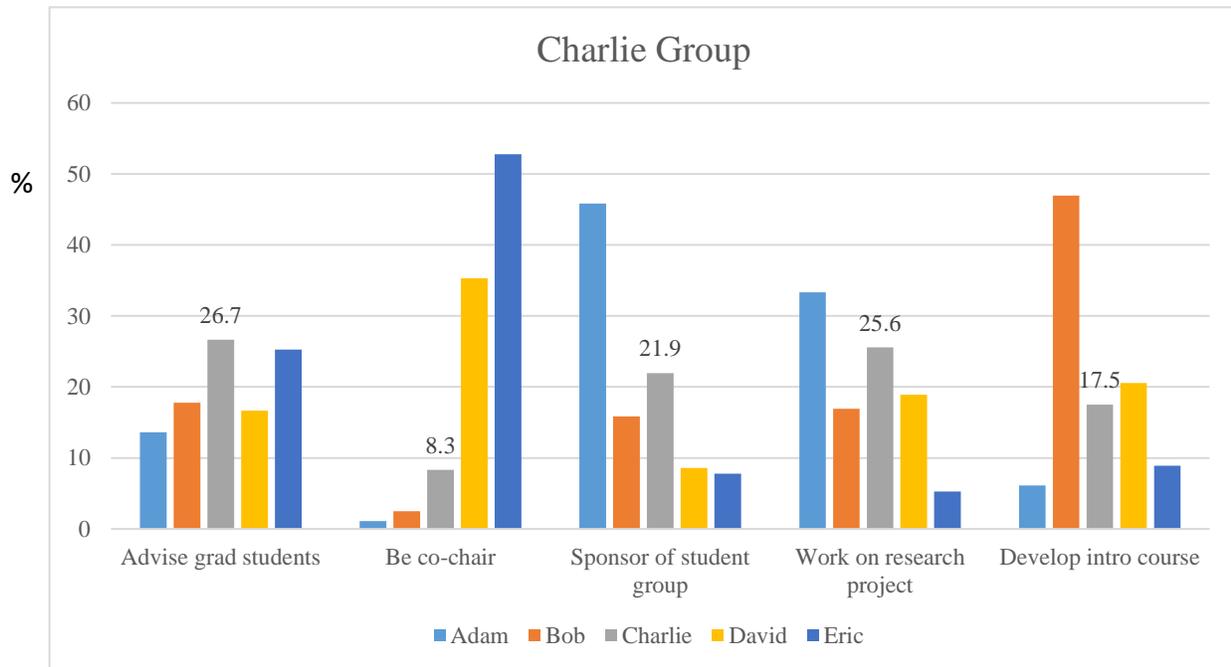


Figure 2. Responses from Charlie form of ARSLA.

Taken by itself, there do not appear to be any oddities with the distributions that were yielded from the Charlie form. The interesting distinctions arise when these results are compared to the results from the Cathy group (Figure 3).

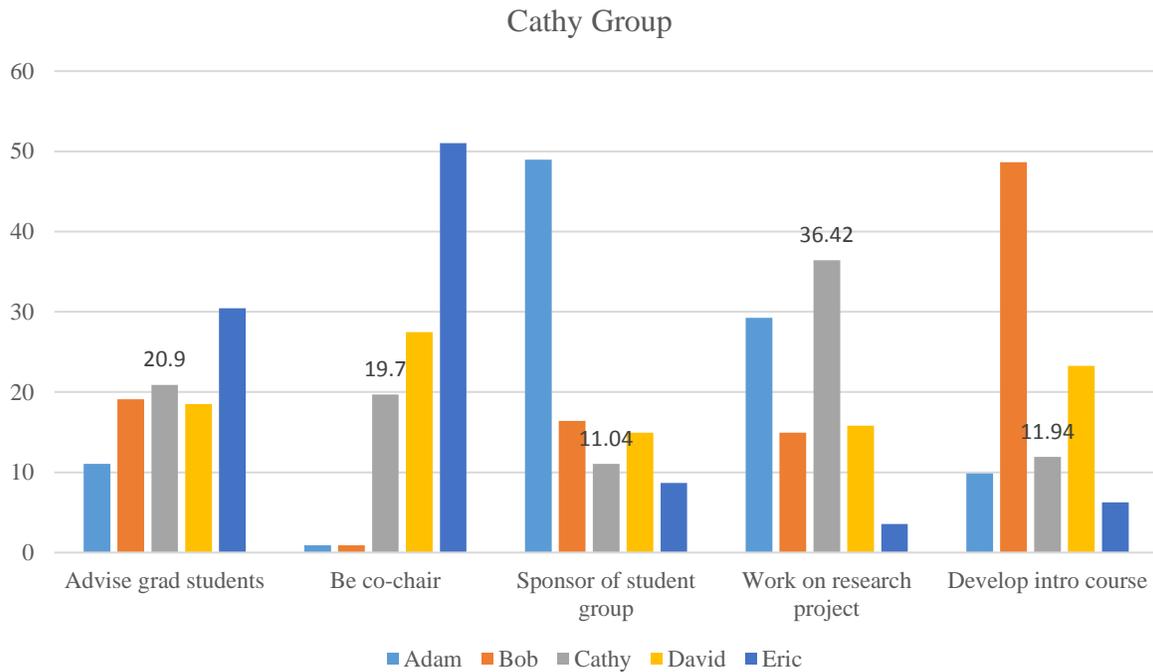


Figure 3. Responses from Charlie form of ARSLA

The probability of Cathy being recommended to be the co-chair of the department was more than twice that of what it was for Charlie. Additionally, Cathy was recommended to work on the new NSF research project 42% more often than Charlie.

These results are contradictory to the predictions supported by prior research. Although no well aligned earlier research existed, studies done on job sorting and job segregation support predictions that both implicit and explicit biases would detract respondents' inclination to promote Cathy to positions of leadership and research. The implications and consequences of these highly interesting results are addressed in the Discussion section.

Gender-Based Differences of Respondents

Data were disaggregated based on the gender of the respondents. Analysis indicated that male and female respondents recommended Charlie and Cathy similarly for the leadership position of being the co-chair of the department (Figure 4). Similar to the overall analysis, male and female respondents advocated for Cathy to be the co-chair at a rate more than double what was recommended for Charlie.

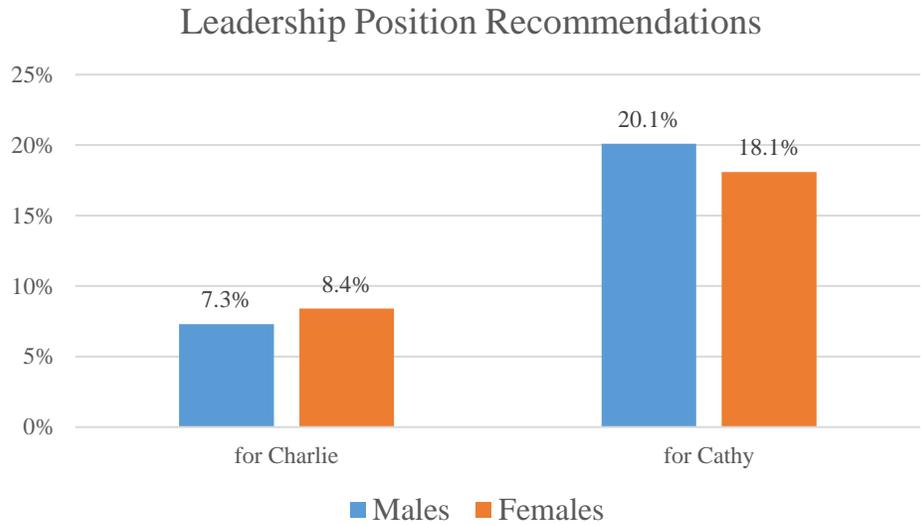


Figure 4. Leadership position recommendations based on respondents' gender.

Although recommendations for the leadership position were similar among men and women, recommendations differed considerably for the research position (Figure 5). Although substantially greater proportions of the male and female groups recommended Cathy more often than Charlie for the research position, women did this at a significantly higher rate than men.

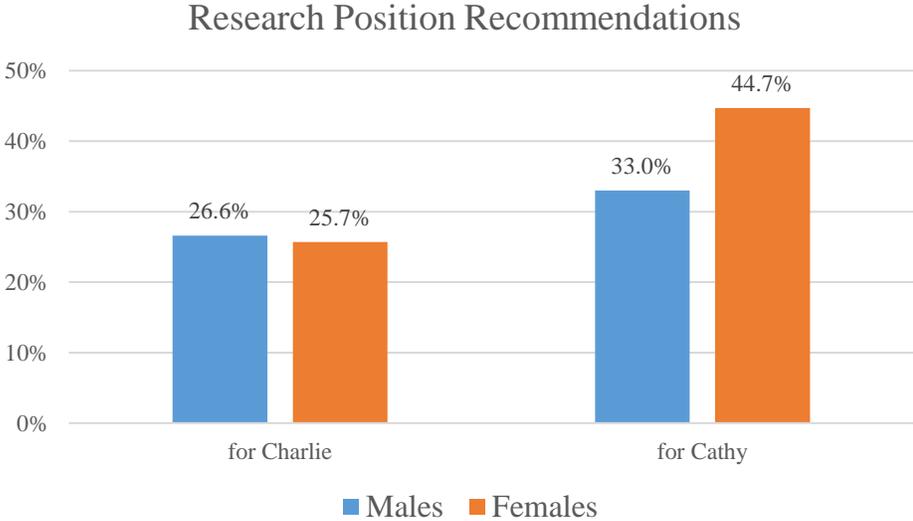


Figure 5. Research position recommendations based on respondents' gender.

Table 2 provides the calculated odds ratios comparing the likelihoods of (1) Cathy versus Charlie being selected to the leadership and research positions and (2) Cathy being selected for both of these positions by women versus men.

Table 2. Odds ratio summaries.

	Recommended to leadership role	Odds Ratio	Recommended to research role	Odds Ratio
Cathy selected by everyone Charlie selected by everyone	.25 .09	2.7	.57 .34	1.67
Cathy selected by women	.22	.88	.81	1.64
Cathy selected by men	.25		.49	

Following assigning the tasks to the faculty members, respondents were asked to provide open responses regarding their reasons for the assignments they had made. Response rate to this item was 71.1% for the Charlie group and 73.1% for the Cathy group. For this analysis, the emphasis was placed only on the Cathy group and in discovering any gender-based reasons for assigning her to the different tasks. It is noted that the Cathy group respondents were not specifically asked to what degree, if at all, gender played a role in their decision-making process. However, 7% of the respondents indicated specifically in their open responses that gender did indeed play a role in their thought processes when recommending Cathy to either the leadership role or the research role.

The following is typical of a response indicating gender influencing the decision to recommend Cathy to be the co-chair:

Women are needed in visible positions; grooming for administration.

The following is typical of a response indicating gender influencing the decision to recommend Cathy to work on the research project:

[Cathy] has previous PI experience, only woman in the department & women often get assigned to administrative and teaching roles rather than research

Discussion

Contrary to a predicted demonstration of a confluence of both implicit and explicit biases in favor of assigning men to research and leadership positions, results support a bias correction theory perspective (not to be confused with sample selection bias). When respondents were presented with bios that included Cathy instead of Charlie, Cathy was 2.36 times more likely to be recommended to the leadership role of co-chairing the department. Similarly, the odds of Cathy being recommended to work on a serious research project was 1.67 times higher than odds

for Charlie. In absence of a female to select from, Charlie was far more often assigned to curriculum development and advising roles than Cathy. There were substantially different responses regarding how a male versus a female, with exactly the same biographical information, should be recommended to duties.

A bias correction theory supports the results. A bias correction occurs when an individual feels that biases toward another individual or group have occurred in the past and in an attempt to be neutral bias is exhibited in the opposite direction. This concept has been explored in the area of biases among jurors.^{20, 21} Researchers have also shown that individuals often use their knowledge of biases in order to arrive at what they feel are justified or appropriate judgments.²²

Disaggregation of data indicated male (n = 483) and female (n = 193) respondents were similarly favorable about recommending Cathy to a leadership role versus Charlie (18% and 20% for Cathy, 11% and 7% for Charlie - female and male respondents, respectively). Significant contrasts existed regarding recommending Cathy or Charlie to a serious research project. Male and female respondents both indicated a preference for Cathy versus Charlie to work on research, but the odds ratio of female respondents versus male respondents selecting Cathy to work on research was 1.64. Female respondents were twice as likely to recommend Cathy to work on research as they were to recommend Charlie (45% versus 23%).

The fact that women, versus men, were more inclined to recommend Cathy for the research position leads to the conjecture that a bias correction mechanism is more pronounced for the research position for women. The following response from a female respondent, regarding why she selected Cathy for the research role exemplifies this disposition:

This is the only opportunity that will advance the woman's career, since research, not service is the only thing that many universities care about. Women often focus too much on helping the team, an act that receives little to no recognition, as it is expected of women.

Additionally, why the leadership position was selected more often for Cathy than Charlie must be examined through follow-up analysis and further research. If the position of co-chair is deemed as a role suited best for a person who possesses interpersonal and social skills and this in turn is reckoned to be better matched for a woman, then these specific facets of leadership must be considered as directing decision-making. We must also reconsider that the leadership position of being the co-chair of a department may be viewed more as simply an administrative position laden with managerial responsibilities and not as a genuine leadership role.

What can be surmised from this study is that on the whole engineering faculty are shifting in their predilections regarding gender biases. This may mark a tipping point when the work of organizations such as the National Center for Women and Information Technology (NCWIT)²³,²⁴ has begun to nudge attitudes and awareness of underrepresentation of women in engineering and computing sciences and actually shift actions.

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Appendix

Assignment of Research, Service, and Leadership Activity [Cathy Version]

Pretend you are Associate Dean in the Engineering & Computer Science College at State Research University (SRU). The Engineering College has 14,000 undergraduate students and 4,000 graduate students. Mechanical & Manufacturing Engineering is the largest department in the college. There are several tasks and opportunities that need to be recommended to members of the Mechanical & Manufacturing Engineering Department. Below are 5 faculty members who have room in their schedules. You are to make recommendations for the upcoming academic year. You must make recommendations based on the limited information below.

Assume research interests of all people are similar.

Adam – is an Assistant Professor in his 2nd year. His dissertation, focused on computer-integrated processes and manufacturing methods, received an award from the Society of Manufacturing Engineers (SME). He enjoys teaching his undergraduate engineering courses where he tries to limit lecturing and get students involved. Adam continues to develop his research agenda and his time has been fairly well protected and not taxed with many extra duties.

Bob – is an Assistant Professor who submitted his tenure package two months ago and is waiting to hear back. He has a strong publication record focused on automation in the manufacturing process, and he co-authors with colleagues at other universities. He helped develop the Engineering Sciences minor for non-engineering students, focusing on the societal role of engineering.

Cathy – has been an Associate Professor for three years. She is well liked by students and her student evaluations are above departmental average. She has an active research lab and is PI of a 5-year NSF research grant (now in year 3). In addition to a PhD, she also holds an MS in human systems engineering. She additionally worked at Ford on manufacturing process planning for 6 years.

David - has been an Associate Professor for six years. His classes are known for being interactive and he received a college teaching award two years ago. Before coming to the university he worked in the Advanced Manufacturing Office of the U.S. Department of Energy where he was involved with research related to next generation electric machines. He has also managed teams of engineers working on advanced manufacturing projects.

Eric – is a full Professor with ties to local manufacturing industry. He has often helped seniors and graduate students secure internships and entry-level jobs. Recently he has helped develop a Research Experiences for Undergraduates (REU) project within the college. He has a consistent record of research that has led to publications, grants, and related patents. Eric plans to retire in 5 years.

For each of the individuals above, indicate below ONE responsibility you recommend for them. **Each person must be recommended to only one of the following** responsibilities. Place the person's first initial (A-E) next to your recommendations.

- ___ Advise incoming graduate students to help them find an advisor in their research area.
- ___ Act as Department Co-Chair for the upcoming academic year with a full professor. The Department Chair will be on sabbatical.
- ___ Be the faculty sponsor for the student chapter of the Society of Manufacturing Engineers (SME).
- ___ Work with professors from the Materials Science Department on an NSF research project focusing on materials processing and manufacturing research [a topic of interest to all 5 of these faculty members]
- ___ Work with two other faculty members to develop a new Intro to Engineering course for freshmen. Course to focus on interdisciplinary nature of engineering and emphasize ethics & societal values.