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BMES BIOMEDICAL ENGINEERING SOCIETY

EDITORIAL

Innovation and Entrepreneurship in Promotion and Tenure in Biomedical Engineering: Communication from the Biomedical Engineering Society Long Range Planning Committee

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Abstract
Promotion and tenure (P&T) remain the central tenets of academia. The criteria for P&T both create and reflect the mission of an institution. The discipline of biomedical engineering is built upon the invention and translation of tools to address unmet clinical needs. 'Broadening the bar' for P&T to include efforts in innovation, entrepreneurship, and technology-based transfer (I/E/T) will require establishing the criteria and communication of methodology for their evaluation. We surveyed the department chairs across the fields of biomedical and bioengineering to understand the state-of-the-art in incorporation, evaluation, and definition of I/E/T as applied to the P&T process. The survey results reflected a commitment to increasing and respecting I/E/T activities as part of the P&T criteria. This was balanced by an equally strong desire for improving the education and policy for evaluating I/E/T internally as well as externally. The potential for 'broadening the bar' for P&T to include I/E/T activities in biomedical engineering may serve as an example for other fields in engineering and applied sciences, and a template for potential inclusion of additional efforts such as diversity, equity, and inclusion (DEI) into the pillars of scholarship, education, and service.

Keywords Promotion · Tenure · Innovation · Entrepreneurship · Technology-based transfer

Introduction

The promotion system within academia reflects and rewards individual efforts in scholarship, teaching, and service with tenure; this in turn secures one's academic freedom. In the basic sciences, promotions have been evaluated based on the candidates' publications and funding, didactic teaching and mentoring experience, and service both at the institutional level as well as in the community. The field of engineering has historically appreciated a 'broadening of the bar' to include translational science, which is reliant on the principles of

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innovation, entrepreneurship, and technology-based transfer (I/E/T).[[[1]]] Yet, how to codify and account for efforts in I/E/T in the promotion and tenure (P&T) system remains a challenge, both culturally and procedurally. Questions remain on whether and how efforts in I/E/T complement or compare to classical outputs (e.g. number of papers, prestige of journals, authorship placement, and amount and type of funding). As the fields of bioengineering and biomedical engineering bridge basic and applied science with medicine, our community is uniquely positioned to instruct the conversation of I/E/T inclusion in P&T. It is unclear whether this will be met with differing acceptance or resistance by P&T committees within a School (College) of Medicine or School (College) of Engineering, and if there are common challenges for establishing the criteria and training for evaluating I/E/T in P&T. Therefore, we conducted a survey of the Chairs of Biomedical or Bioengineering Departments across institutions based in the United States to compile current opinions and experiences regarding I/E/T in the P&T system.

Methods

The Biomedical Engineering Society (BMES) Long Range Planning Committee first convened in September of 2022 to discuss the inclusion of innovation and entrepreneurship (I/E/T) in P&T considerations. The objective of this project was to conduct a survey of best practices to identify areas of opportunity for the inclusion of I/E/T into the P&T system.

To this end, the Long Range Planning Committee distributed a survey to the Council of Chairs (CoC) of Bioengineering and Biomedical Engineering. This council is comprised of one chair (or an equivalent position) from most of the bachelors, masters, or doctoral degree-granting programs in bioengineering or biomedical engineering in the United States, plus several international members. The survey used in this project was adapted from a previous study conducted by Oregon State University.[[[2]]] In brief, our survey asked respondents to identify what department their faculty are primarily appointed to, which school their department resides in, and in what capacity they have previously served on department or university P&T committees. The subsequent questions were focused on identifying policies and criteria used to evaluate faculty I/E/T.

Surveys were distributed in October of 2022 and participants given one month to respond. Two reminder emails were sent approximately two weeks apart. At the conclusion of the study, the survey results were downloaded from Qualtrics and data were analyzed using GraphPad Prism 9 (Version 9.5.0).

Results

Of the 156 (primarily) US-based bioengineering or biomedical engineering CoC member programs, Department Chairs from 52 programs completed the survey, for a 33% response rate. These representatives reported that their faculty are predominantly appointed to the Department of Biomedical Engineering (71%), followed by the Department of Bioengineering (21%) (Fig. 1a). Similarly, school affiliation was reported to be heavily in the School/College of Engineering (75%), followed by the School/College of Engineering and Medicine (10%) and the School/College of Medicine (8%) (Fig. 1b). All of the Department Chairs with appointments in a medical school were affiliated with a Biomedical Engineering rather than a Bioengineering Department. Regarding the respondents' previous involvement on department or university P&T committees, 42% have previously served as the Committee Chair, 54% have been participating members, and 4% report never having served on a P&T committee (Fig. 2). Eight out of the 9 Department Chairs with faculty appointments in a School of Medicine had served on a P&T committee.

After collecting basic demographic information, the subsequent survey questions were intended to gauge the respondents' perceptions and experience with policies and trainings surrounding the inclusion of I/E/T in P&T considerations. With respect to the current climate at academic institutions, 60% of survey respondents felt that I/E/T is evaluated during P&T evaluations; however, only 35% said that there were policies in place to help guide these evaluations and 71% said that they did not receive training on how to evaluate other faculty members' I/E/T contributions. This is interesting as 57% agreed that there is training on how to participate in I/E/T activities (Fig. 3a). Regarding future directions for

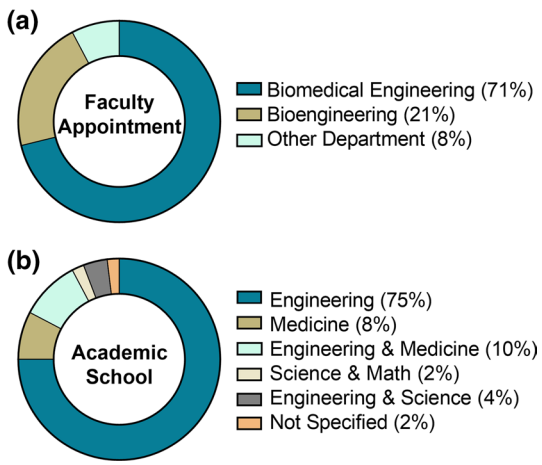

Fig. 1 Faculty appointment and school affiliated with degree-granting programs in bioengineering or biomedical engineering

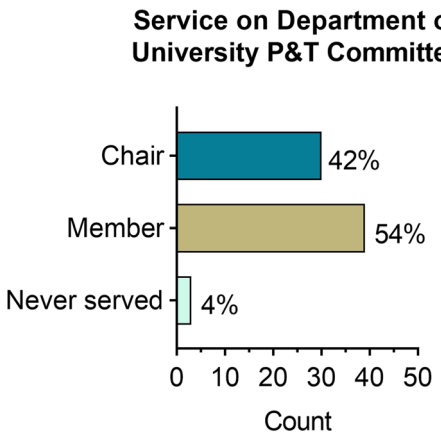

Fig. 2 Previous involvement of program chairs (or equivalent position) on department or university P&T committees

I/E/T policies and trainings, only 2% of respondents said that I/E/T should not be considered for P&T, and the majority of respondents would like to introduce more policies and trainings that guide the integration of I/E/T in P&T (Fig. 3b).

The next set of questions addressed how respondents viewed faculty I/E/T in the context of P&T evaluation criteria. Interestingly, respondents were split on whether faculty I/E/T is currently perceived to be on par with traditional academic achievements (e.g. publications, grants) in P&T considerations, with 42% of respondents agreeing and 44% disagreeing. In a similar fashion, 39% felt that faculty I/E/T is associated with social benefits and broader impacts, whereas 45% disagreed. Overall, 78% felt that I/E/T activities were treated as optional bonuses for P&T (Fig. 4a). In terms of how respondents wanted faculty I/E/T to be counted going forward, the responses were divided between agreeing and being neutral that faculty I/E/T should be evaluated comparably with traditional academic behaviors, have the potential to impact social standing, and remain optional for P&T consideration (Fig. 4b).

The final survey question queried respondents to determine which faculty I/E/T outputs should be considered in P&T evaluation criteria. The top five outputs that respondents indicated a strong desire to factor into P&T considerations included: receiving technology-related grants (84%) or industry-sponsored research funding (78%), having a patent issued (71%), transferring technology (71%), or having licenses executed (67%). The three least desirable criteria were receiving copyrights (56%), filing patent applications (54%), and starting a company (49%) (Fig. 5).

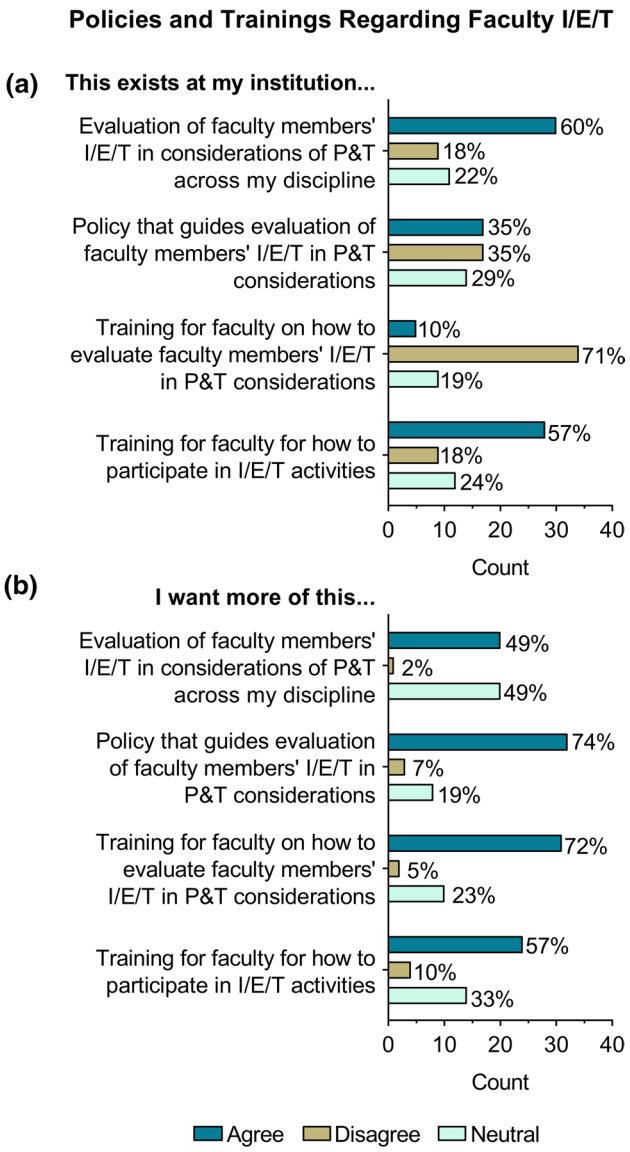

Fig. 3 Attitudes surrounding current and desired policies and trainings focused on implementing faculty I/E/T in P&T considerations

Discussion

Career development within academia is in large part linked to and tracked by the P&T system. The rise in rank from assistant to associate and finally full professor reflects contributions to scholarship, teaching and service at the local, regional and national levels. Evaluation of what constitutes satisfactory, substantial, and outstanding contributions to each of these tenets is subjective.[[[1]]]. For scholarship, typical activities include publications and grants, with metrics including number of papers, journal impact factors, individual h-index ranking, and overall amount of funding. As reflected by the data in our survey, there is a strong desire within academia and the biomedical and bioengineering fields in particular to broaden the activities evaluated as part of scholarship to include innovation and entrepreneurship. Accomplishing that goal will require developing policies that define which I/E/T activities reflect satisfactory, substantial, and outstanding

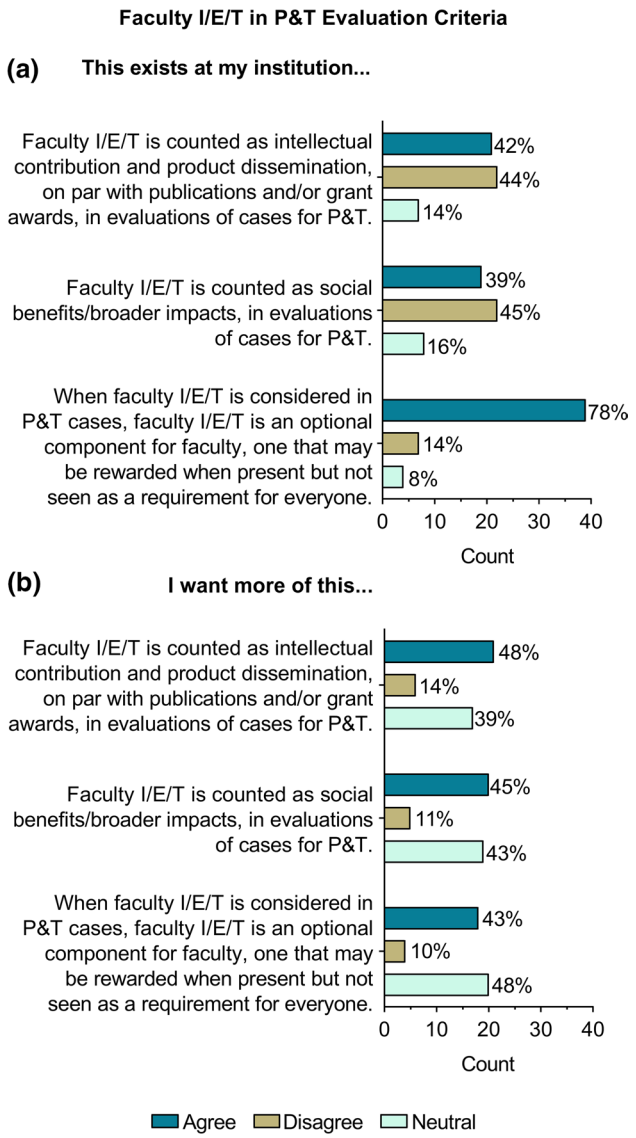

Fig. 4 Perception of how faculty I/E/T is factored into P&T considerations

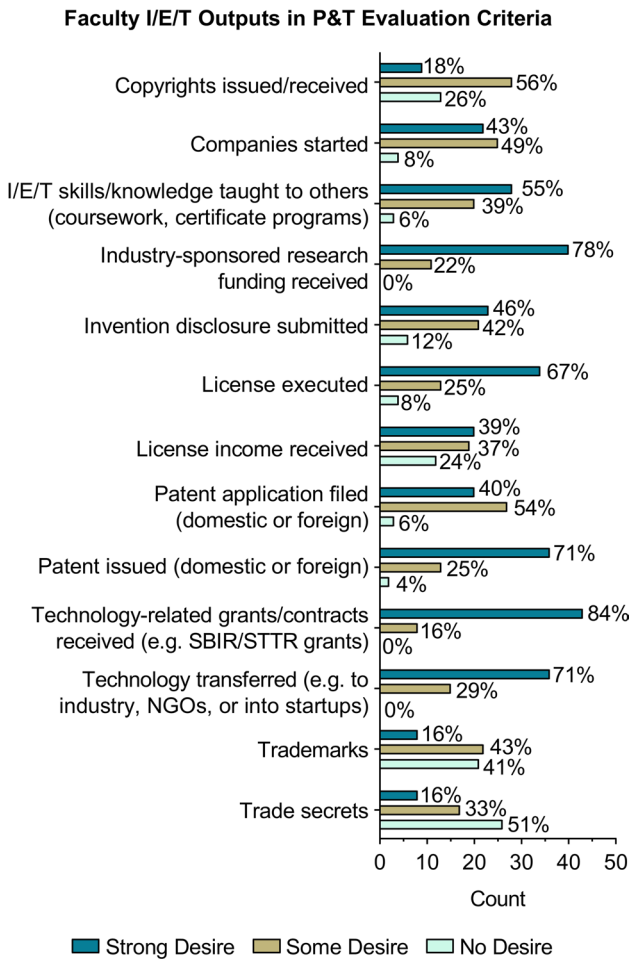

Fig. 5 Preferences for faculty I/E/T deliverables to be included in P&T evaluation criteria

contributions, as well as educating evaluators in the use these policies.

At the majority of institutions, P&T regulations and practices are codified and standardized in a university-wide faculty handbook. Likewise, once a candidate for P&T is recommended by their School of Engineering or Medicine, their dossier typically undergoes an additional level of review by a university-wide committee. Once the committee has completed their review, the dossier must be approved by the provost and a board of trustees. Thus, to enact a real change with effective incorporation of I/E/T metrics into the P&T process, complete buy-in and acceptance at the university level is imperative. At some institutions, this may be best accomplished through the faculty senate, whereas at other institutions this may be achieved through the advocacy of deans to their provost.

Even for institutions that update their policies and educate their committees on the inclusion and evaluation of I/E/T activities as part of the P&T process, there remains the challenge of soliciting external reviewers who likewise value I/E/T as part of the evaluation process. To address this, departmental P&T committees should provide clear instructions to candidates on how to summarize their I/E/T contributions and how to incorporate these contributions into their dossier. Likewise, external reviewers need to be provided clear instructions on how to evaluate and rank I/E/T activities in terms of satisfactory, substantial, and outstanding contributions to scholarship. The desire to incorporate I/E/T activities in the P&T process is largely a shared value across the biomedical and bioengineering fields. Sharing best practices and policies as part of workshops and seminars, and integrating I/E/T tracks into scientific meetings (e.g. BMES Annual Meeting), would help reinforce the importance of I/E/T in the P&T process. Additionally, potential external

reviewers can be identified from over 65 institutions of higher education that participate in the P&T Innovation and Entrepreneurship (PTIE) Network. Ultimately, educating letter writers on institutional I/E/T policy is crucial for a fair and accurate evaluation of candidates for P&T, which can be achieved through clear communication and nationally-led efforts to establish the value of I/E/T in the biomedical and bioengineering discipline.

Another important issue not directly addressed in our survey is how I/E/T activities are incorporated into the promotion processes for non-tenure track research faculty. While these practices are less standardized across US-based universities, many of our institutions utilize a parallel track of research assistant/associate/full professor career development, or employ a distinct rank of non-tenure track professors of the practice. However, promotions for non-tenure track research faculty are strongly, if not solely evaluated on scholarship. Moreover, the processes for non-tenure track promotions are often simplified and more streamlined in terms of requirements for external letters, making the evaluations themselves more subjective. This stems in part from the fact that research-prefixed faculty may be fully funded by grant and contract support, and thus do not represent a lifetime commitment from the institution. Nevertheless, the intellectual contributions of these valuable colleagues in terms of their technology translation and real-world impact should be codified and clearly communicated to each faculty member.

Finally, as I/E/T criteria for P&T become more established within the fields of bioengineering and biomedical engineering, faculty hiring processes should be adjusted accordingly. Specifically, if commercialization and entrepreneurial activities are to be strongly factored into P&T decisions, then faculty job postings should reflect these values. Moreover, the rubrics used by faculty search committees should evaluate how the potential candidates align with these I/E/T criteria. Only then can junior faculty find the best fit for themselves, where their research and translation goals will be recognized and rewarded by their senior colleagues and administrators.

In summary, if the field of biomedical and bioengineering desires to fulfil its mission of improving health through the creation and translation of novel tools and therapies, the P&T system needs to reflect the value of I/E/T activities as an essential component to scholarship. Improved policies, guidelines, and communication is key to broadening the P&T bar.

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Author Contributions RGC, KM, and OJTM, were responsible for study conception. OJTM and TCLK contributed to data collection and analysis. TCLK, SNC, PII, MRK, and OJTM drafted the manuscript. AR and GB critically reviewed the manuscript.

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Data Availability The data used in the study are available upon request from the corresponding authors.

Declarations

Conflict of interest The authors declare no conflicts of interest.

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