



Pre and Post Tenure: Perceptions of Requirements and Impediments for Mechanical Engineering and Mechanical Engineering Technology Faculty

Dr. Benjamin B Wheatley, Bucknell University

Benjamin Wheatley was awarded a B.Sc. degree in Engineering from Trinity College (Hartford, CT, USA) in 2011 and a Ph.D. in Mechanical Engineering from Colorado State University (Fort Collins, CO, USA) in 2017. He is currently an Assistant Professor in the Department of Mechanical Engineering at Bucknell University (Lewisburg, PA, USA). His pedagogical areas of interest include active learning approaches, ethics, and best practices as they relate to computational modeling. He runs the Mechanics and Modeling of Orthopaedic Tissues Laboratory at Bucknell, where they use computational and experimental techniques to better understand the mechanics of musculoskeletal soft tissues and human movement.

Dr. Elif Miskioğlu, Bucknell University

Dr. Elif Miskioğlu is an early-career engineering education scholar and educator. She holds a B.S. in Chemical Engineering (with Genetics minor) from Iowa State University, and an M.S. and Ph.D. in Chemical Engineering from Ohio State University. Her early Ph.D. work focused on the development of bacterial biosensors capable of screening pesticides for specifically targeting the malaria vector mosquito, *Anopheles gambiae*. As a result, her diverse background also includes experience in infectious disease and epidemiology, providing crucial exposure to the broader context of engineering problems and their subsequent solutions. These diverse experiences and a growing passion for improving engineering education prompted Dr. Miskioğlu to change her career path and become a scholar of engineering education. As an educator, she is committed to challenging her students to uncover new perspectives and dig deeper into the context of the societal problems engineering is intended to solve. As a scholar, she seeks to not only contribute original theoretical research to the field, but work to bridge the theory-to-practice gap in engineering education by serving as an ambassador for empirically driven, and often novel, educational practices.

Dr. Eliana Christou, University of North Carolina at Charlotte

Dr. Nicholas Tymvios, Bucknell University

Nicholas Tymvios received a B.S. and M.S. degree in Civil Engineering from Purdue University in 1999, and 2002 respectively. After working for four years in Cyprus in the construction industry, he was accepted into the Ph.D. program at Oregon State University, where he graduated in 2013 with a degree in Civil Engineering with emphasis in Construction Engineering and Management. His area of concentration is construction safety, and in particular Prevention through Design. Upon graduation, he worked for four years as an Assistant Professor at UNC-Charlotte. He is currently an Assistant Professor in the Department of Civil & Environmental Engineering at Bucknell University (Lewisburg, PA, USA).

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Abstract

The tenure process began in the United States in 1915, and since then it has been the subject of both commendation and condemnation. Still, the tenure process is the norm in the majority of higher education institutions in the United States. Tenure remains highly desirable for many in academia, and those in mechanical engineering and mechanical engineering technology are no exception.

This paper aims to 1) determine the variability in perceptions of tenure requirements among both assistant and associate professors in mechanical engineering and mechanical engineering technology programs and 2) identify perceived impediments for faculty seeking to obtain tenure. Similar surveys were sent to assistant and associate professors in the same programs for reporting perceptions of tenure requirements and to identify the impediments they faced towards their tenure process. The motivation for this research is to bring to the surface perceptions and concerns assistant professors have in obtaining tenure, and to identify if these concerns were also true to already tenured faculty.

Faculty from ABET accredited programs in tenure-track positions were identified through an online search, and were provided with an online survey to complete. Faculty responses were categorized according to the Carnegie Classification of Institutions of Higher education that classifies institutions according to their research activity.

The authors hope that this paper will spark conversations regarding clarity of requirements, and a discussion about work-life balance for those on the tenure path.

Key words: Tenure, Mechanical Engineering, Impediments, Perceptions, Faculty

Introduction

Tenure is perceived by many to be a foundational component of academic structure and careers for those in academia [1]. While non-tenure track positions in academic institutions may be increasing across the nation [2], tenure track positions remain foundation for many mechanical engineering departments across institutions of various sizes. Tenure is generally accepted as highly desirable and enables faculty to diversify, pivot, or concentrate their scholarly and pedagogical activities by providing employment stability and consistency [3]. While matters such as mandatory retirement remain in contention regarding tenure [4], requirements for achieving tenure is most often a topic of discussion among tenured and tenure track faculty. However, the path to tenure, impediments for pre-tenure faculty to achieve tenure, and expectations (or requirements) to achieve tenure are not consistent due to a range of variables [5-6]. Institution size, research productivity, economic circumstance, historical trends, and strategic planning (among other factors) can all play a role in expectations and requirements for achieving tenure.

There exists variability between institutions, departments, and even personnel for what is generally perceived as being necessary for faculty to achieve tenure. Furthermore, the impediments and perceived impediments for tenure track faculty may range significantly between institutions. While all faculty are subject to the same global time restrictions of 24 hours per day and 52 weeks per year, and indeed people have a range extracurricular and personal commitments and needs, maintaining a proper work-life balance remains a challenge [7]. The tenure process is also inherently designed as a “closed system”, which may lead to bias and discrimination in some cases [8]. Thus, the goal of this work was to develop, employ, and present the results of a survey administered to tenure-track and recently tenured mechanical engineering faculty members that provides insight into tenure expectations and impediments.

Specifically, we hope to provide insight into time commitments, teaching loads, expectations and/or requirements for scholarly activities such as journal article publications and grant funding, guidelines for tenure, and impediments for achieving tenure across different categorical institutions and among tenure-track and tenured faculty [9]. Surveying was performed on ABET-accredited mechanical engineering programs across the United States. We hope that the data presented here can facilitate conversations amongst faculty – both pre and post tenure – regarding appropriate expectations, mentoring, and maintaining a work-life balance in both the general structure of academia as well as on a departmental and even personal level.

Methodology

The survey was conducted during the Fall 2019 semester. Two notification emails were sent to a total of 3,158 faculty identified. Mechanical Engineering and Mechanical Engineering Technology faculty were defined as the faculty belonging in programs accredited by the Accreditation Board of Engineering and Technology (ABET). In total 339 different programs were identified for mechanical engineering, and 66 programs for mechanical engineering technology (<https://www.abet.org/>). The responses to the survey were collected using Qualtrics, an online survey service. Participants were emailed a link to the survey along with an explanation of the purpose of the survey. After approximately two weeks, a reminder was sent to the participants who did not respond.

Contact information of these faculty members with the rank of Assistant and Associate Professor was compiled from an internet search of the various department/school websites. The departments/schools were further identified and categorized according to the 2018 Carnegie Classification of Institutions (<https://carnegieclassifications.iu.edu/index.php>) they belonged to as follows:

- R1: Doctoral Universities – Very high research activity,
- R2: Doctoral Universities – High research activity,
- D/PU: Doctoral/Professional Universities,
- M1: Master's Colleges and Universities – Larger programs,
- M2: Master's Colleges and Universities – Medium programs,
- M3: Master's Colleges and Universities – Smaller programs, and
- Baccalaureate Colleges: Arts & Science Focus or Engineering Focus.

The survey consisted of questions of identification and differentiation such as demographics, name of institution faculty is serving, their title, and time in current position. The survey participants were also asked to identify if they were tenured or in tenure-track positions. Participants were also asked to identify the percentage of time they spend on Research/Teaching/Service/Other activities and state that percentage according to their departmental guidelines for their job description.

Some faculty have been given specific guidelines and requirements to earn tenure. Survey participants were asked to respond if they had such information, and provide these guidelines in terms of “Teaching Work Load”, “Teaching Evaluation Metrics”, “Research Dollar Amount”, “Number of Peer Reviewed Journal Articles”, “Participation in Conference Proceedings”, and any other guidelines.

Participants that were not provided specific guidelines were asked to state what they think these requirements were in the same categories. Both groups were then asked to state with a “yes” or “no” if they think these guidelines are “Attainable” for faculty members in their discipline and their academic unit, and if their requirements are “Comparable” to faculty in their academic unit but not in their discipline, and “Comparable” to faculty in other departments in their College. Finally, participants were asked to rate the following impediments on their likelihood of influencing the tenure process:

- Teaching load requirements,
- Expectation of peer-reviewed journal publications,
- Service expectations,
- Availability of funds for research in their fields
- Appreciation for area of research by tenure review committee(s)
- Competition within department for funds,
- Availability of Teaching Assistants (TA) to assist with grading,
- Availability of students to employ as researchers,
- Quality of students to employ as researchers,
- Availability of faculty mentoring,
- Quality of faculty mentoring,

- Interdepartmental politics, and
- Managing work-life balance

Results

A total of 3158 participants were identified from different U.S. universities/colleges, of which 266 provided valid responses to the survey (8.43% response rate). Responses included participants from 45 states, DC, and Puerto Rico, and represented faculty from 164 different institutions. The distribution of responses per state is shown in Figure 1. Not shown in Figure 1 are two (2) responses from DC, and one (1) response from Puerto Rico.

One hundred and thirty four (134) of the responders were Assistant Professors (Tenure Track), while 132 were tenured faculty members. The distribution of the responses according to institution type and tenure characterization is shown in Table 1.

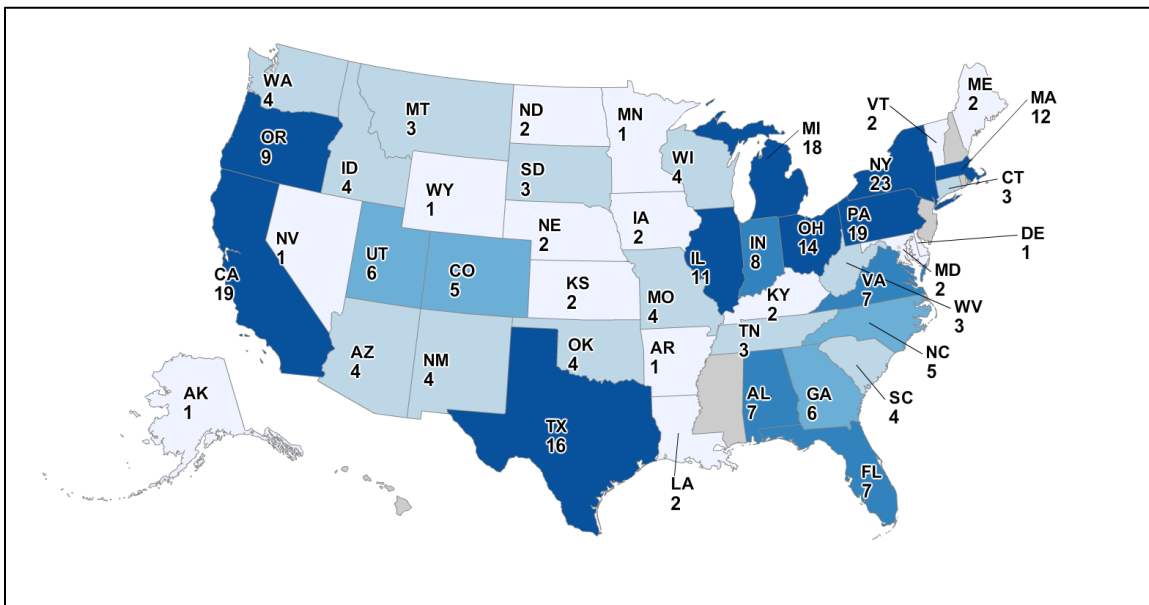


Figure 1: Distribution of Responses

Table 1: Distribution of Responses per Institution Category and Tenure

Institution Category	TT	Tenured	Total
R1	72	61	133
R2	36	35	71
D/PU	8	10	18
M1	10	11	21
M2	2	6	8
M3	2	3	5
B	4	6	10
Total	134	132	266

Participants were further classified according to their sub-discipline within Mechanical Engineering, and Mechanical Engineering Technology. A distribution of the various disciplines is shown in Table 2. Participants had the capability to declare more than one discipline, and they were provided with a list of options, as well as the capability to add their own. In the “Other Category, participants responded with a range of sub-disciplines that included: Bioengineering, Engineering Education, Fluid Power, Computer Animation and Game Development, Cyber physical Systems, Environmentally Conscious Design, Nanotechnology, Medical Devices, Nuclear Engineering, Tribology, Vehicle Safety, Humanitarian Engineering, Human factors, Microsystems, Mechanics, and Microfluidics.

Table 2: Distribution of Sub-disciplines

Sub-discipline	Frequency
Aerospace	43
Automotive	12
Biomechanics	49
Computational Analysis	50
Control Systems	21
Design	53
Dynamics & Vibrations	28
Energy and Thermal	80
Fluid Dynamics	69
Manufacturing	37
Materials	67
Robotics	39
Solids	47
Other	29

Some faculty were given specific guidelines and requirements to reach tenure, while others stated that they were not. As shown in Table 3, 53.7% of the TT surveyed stated that they were provided guidelines, while 46.3% of them said they were not. Similarly, 61.4% of the tenured faculty stated that they were provided guidelines, while 38.6% of them said that they were not.

Table 3: Provision of Guidelines

Rank	Guidelines	R1	R2	D/PU	M1	M2	M3	B	Sum	% per Rank
TT	Provided	34	24	2	5	2	1	4	72	53.7%
	Not Provided	38	12	6	5	0	1	0	62	46.3%
Tenured	Provided	30	26	6	9	3	3	4	81	61.4%
	Not Provided	31	9	4	2	3	0	2	51	38.6%
	Sum	133	71	18	21	8	5	10	266	

In the survey, participants were asked to state what these guidelines were if they were provided, while if they were not, they were asked to state what they were perceived to be. The responses are summarized in the following sections:

Teaching Expectations

The faculty were also asked to identify how their teaching expectations look like. This information is tabulated in Table 4 and it is sorted according to the type of institution and the faculty rank (TT or tenured). Because of the low number of responses from Masters and Baccalaureate institutions, their responses were combined. The numbers in the tables indicate the number of responses. Because of the small number of responses it is difficult to distinguish these trends according to sub-discipline, but as expected a general trend of greater number of courses from R1 to M+B institutions is clear.

Table 4: Quantity of Teaching

Type	Rank	Quantity of Teaching per Year (# of responses)			
		1-2 courses	3-4 courses	5-6 courses	7+ courses
R1	TT	32	33	1	-
	Tenured	20	32	1	-
R2	TT	9	14	6	1
	Tenured	2	22	5	1
D/PU	TT	1	-	3	1
	Tenured		-	4	4
M+B	TT	-	3	9	6
	Tenured	-	2	9	12

As observed teaching quantity expectations are lower in R1 institutions with the majority of the faculty teaching 1 to 4 classes per year, with some exceptions. Faculty from PhD Higher institutions teach on average 3 to 4 courses per year with some exception of more or less than that. For faculty from D/PU Moderate and M+B institutions teaching load is on average is 5 to 6 courses per year, with several faculty teaching more than 7 courses per year.

Research Expectations

Similar to teaching expectations, the faculty responding were asked to quantify their research funding expectations. That information is tabulated in Table 5, and it is sorted, according to the type of institution, faculty rank, and whether guidelines were provided at hiring. These data exhibit the important role of research funding at R2 and especially R1 institutions, while to a lesser extent M+B institutions.

Table 5: Research funding expectations

Type	Rank	Guidelines Provided	Amount of research funding by tenure application				
			<\$500k	> \$500k - \$1mill	> \$1mill - \$1.5 mill	>\$1.5 mill	NA or Unspecified
R1	TT	Yes	1	6	2	1	15
	Tenured		3	10	-	1	12
	TT	No	-	19	2	4	8
	Tenured		1	9	1	1	8
R2	TT	Yes	9	1	1	-	7
	Tenured		8	6	-	-	8
	TT	No	2	2	1	1	4
	Tenured		2	3	-	-	2
D/PU	TT	Yes	-	-	-	-	1
	Tenured		2	-	-	-	3

	TT	No	-	-	-	-	5
	Tenured		2	-	-	-	1
M+B	TT	Yes	5	-	-	-	4
	Tenured		12	-	-	-	4
	TT	No	3	-	-	-	2
	Tenured		3	-	-	-	1

Journal Publication Expectations

Faculty were also asked to indicate their journal publication requirements. That information is shown in Table 6, for PhD institutions and the information is sorted per institution type, faculty rank, and whether guidelines were provided. A general trend of increasing number of publications was observed from Master's and Bachelor's institutions to R1 institutions.

Table 6: Journal Publication expectations.

Type	Rank	Guidelines Provided	Number of journal publications by tenure application				
			1-4	5 - 9	10 - 14	15+	NA or Unspecified
R1	TT	Yes	-	1	11	8	8
	Tenured		-	3	12	5	6
	TT	No	1	6	14	8	6
	Tenured		-	2	9	8	7
R2	TT	Yes	3	5	8	-	1
	Tenured		4	8	5	-	7
	TT	No	-	1	9	-	2
	Tenured		-	2	4	-	2
D/PU	TT	Yes	-	-	-	-	-
	Tenured		5	1	-	-	-
	TT	No	1	2	1	-	2
	Tenured		1	1	-	-	1
M+B	TT	Yes	5	5	1	-	1
	Tenured		13	3	-	-	2
	TT	No	2	1	-	-	2
	Tenured		5	-	-	-	-

Attainability of Tenure and Comparability of Tenure Requirements

Regarding attainability and comparability, faculty that were given guidelines were asked to rate whether these guidelines are a true representation of what is expected of faculty in their department to obtain tenure. Their responses are shown according the type of university and according to their rank shown in Table 7. Generally, when guidelines were provided, faculty felt that these were a true representation of what was necessary to achieve tenure.

Table 7: Guidelines given are a true representation.

Rank	Type	Def. Yes	Prob. Yes	Might/Might not	Prob. Not	Def. Not
TT	R1	3	18	3	2	1
	R2	6	9	2	3	1
	D/PU	0	0	1	0	0
	M+B	2	6	2	0	0
Tenured	R1	5	14	6	1	1

	R2	2	13	2	2	5
	D/PU	1	3	2	0	0
	M+B	3	10	2	3	1

Faculty members were asked to state with a “yes” or a “no” if they think these guidelines (provided or perceived) are “Attainable” for faculty members in their discipline and academic unit. They were also asked to respond if they thought the requirements, perceived or otherwise, were comparable to other members of the faculty but not within their discipline, and comparable to other faculty within their college. These responses are summarized in Table 8.

Overwhelmingly faculty perceived these requirements to be attainable and comparable to other programs. It should be noted that our survey does not identify faculty that were not granted tenure, which is likely to influence these survey results.

Table 8: Attainability and comparability of requirements.

Type	Rank	Attainable		Comparable within Department		Comparable to other Departments in the College	
		Yes	No	Yes	No	Yes	No
R1	TT	51	5	39	8	29	16
	Tenured	42	5	39	4	29	8
R2	TT	25	1	19	6	15	10
	Tenured	23	1	19	0	15	8
D/PU	TT	3	1	2	1	1	3
	Tenured	9	0	7	1	5	2
M+B	TT	13	3	11	1	11	1
	Tenured	22	1	11	6	12	7

Time Spent Teaching and Research

Regarding Time spent conducting research and teaching, faculty were asked on their overall hourly commitment to research, teaching, and service activities, shown in Figure 2. Overall, no clear trends or significant observations can be made between rank or institution, suggesting that faculty of all levels and at all institutions commit a similar number of hours per week to their position.

Time Commitments in Research/Teaching/Service

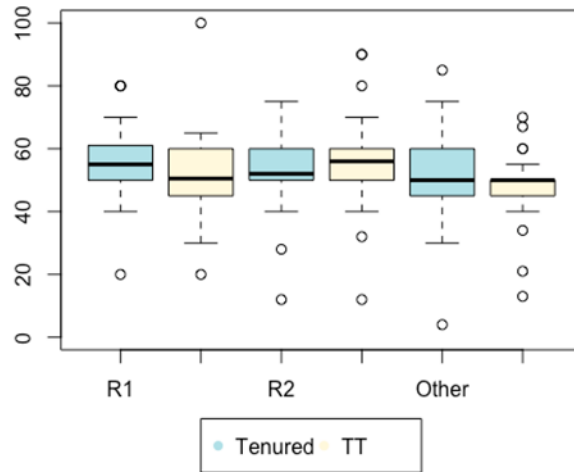
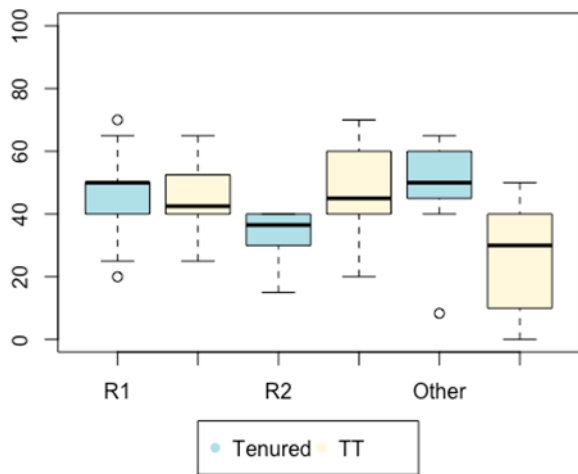


Figure 2: Total faculty time commitment in hours/week, divided into R1, R2, and all other institutions and between TT and Tenured rank.

Faculty were also asked to subdivide their contractual or actual time (as outlined in a contract or other document) into a percentage dedicated to research and a percentage dedicated to teaching. Similarly, they were surveyed on actual time dedicated to these activities as well. These data are shown in Figure 3 (contractual) and Figure 4 (actual). While statistical analysis was not performed on these data, a general observation of a greater teaching time and less research time for tenure track faculty only in non-R1 and R2 institutions suggests there may be discrepancies between tenured and tenure track faculty time commitments.

Contractual % of time: Research



Contractual % of time: Teaching

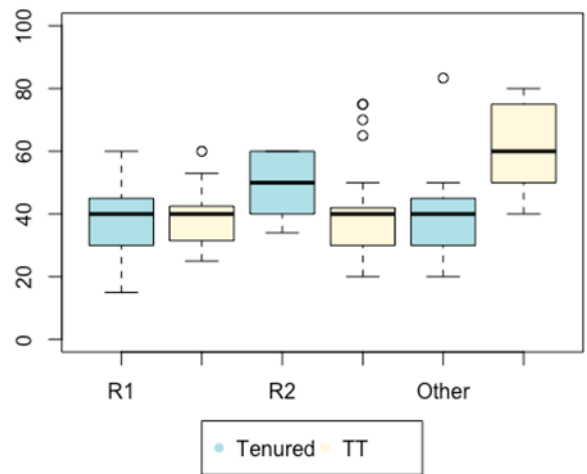


Figure 3: Official time commitments to research and teaching activities per contract or other guidelines divided by institution and rank.

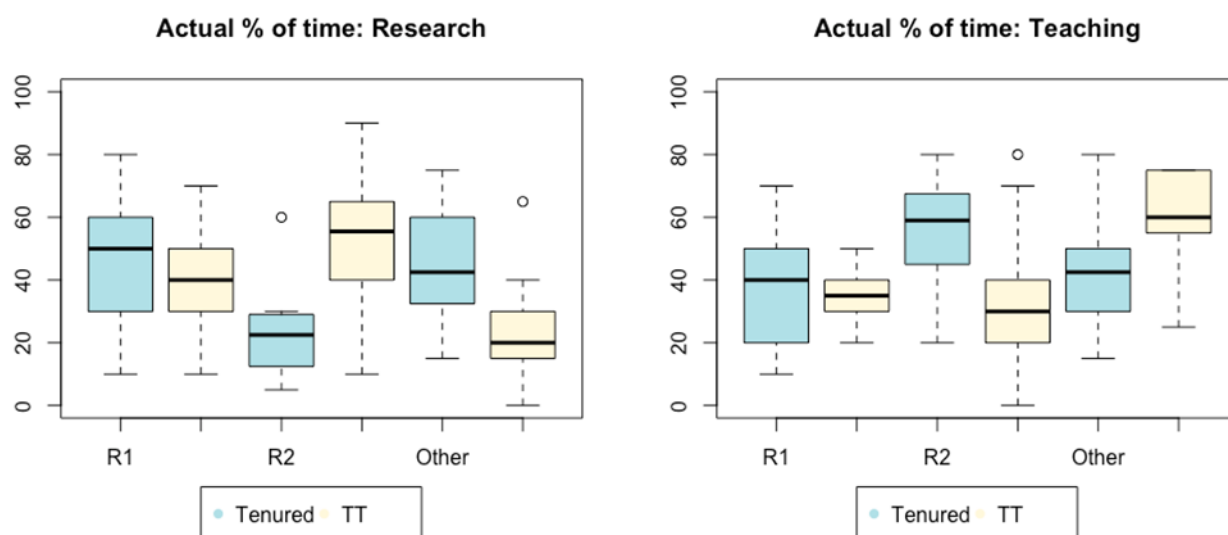


Figure 4: Actual time spent by faculty on research and teaching activities divided by institution and rank.

Impediments

When asked on the impediments to tenure, faculty members rated the likelihood of these impediments affecting their tenure process. That information is shown in Table 9. Highlighted are the combined observations where at least 50% of responses were either likely or unlikely to affect faculty tenure process. These results should be interpreted as “Positive” equates to positively affecting the likelihood to achieve tenure, and “Negative” equates to negatively affecting the likelihood to achieve tenure. As observed, the expectation of peer-reviewed manuscripts was perceived as positively affecting the tenure process, and concerningly, maintaining a work-life balance was perceived as negatively affecting the tenure process.

Table 9: Comparison of impediments

Question	Likely?	Total	TT				Tenured			
			R1	R2	D/PU	M+B	R1	R2	D/PU	M+B
Teaching load	Positive	49%	40%	32%	43%	56%	62%	41%	67%	67%
	Neither	15%	16%	26%	14%	17%	12%	19%	0%	8%
	Negative	36%	44%	42%	43%	28%	27%	41%	33%	25%
Expect. of peer-reviewed journal publications	Positive	61%	52%	67%	43%	44%	77%	59%	88%	58%
	Neither	24%	31%	23%	29%	28%	17%	25%	0%	29%
	Negative	14%	16%	10%	29%	28%	6%	16%	13%	13%
My service expectations	Positive	40%	25%	50%	43%	33%	45%	31%	44%	71%
	Neither	39%	50%	33%	57%	28%	38%	44%	22%	17%
	Negative	22%	25%	17%	0%	39%	17%	25%	33%	13%
Availability of funds for research in my field	Positive	42%	41%	53%	29%	29%	56%	38%	33%	23%
	Neither	22%	29%	13%	14%	24%	13%	16%	44%	36%
	Negative	36%	30%	33%	57%	47%	31%	47%	22%	41%
Apprec. for my area of research by review commit.	Positive	42%	54%	40%	17%	41%	57%	29%	33%	40%
	Neither	29%	17%	40%	67%	24%	31%	39%	56%	35%
	Negative	22%	29%	20%	17%	35%	12%	32%	11%	25%

Competition within academic unit for funds	Positive	14%	16%	26%	17%	23%	14%	20%	0%	17%
	Neither	54%	63%	52%	67%	46%	77%	52%	88%	78%
	Negative	15%	21%	22%	17%	31%	9%	28%	13%	6%
Availability of TA for grading	Positive	37%	46%	45%	29%	36%	52%	22%	14%	36%
	Neither	25%	26%	14%	43%	14%	28%	38%	57%	21%
	Negative	29%	28%	41%	29%	50%	20%	41%	29%	43%
Availability of students as researchers	Positive	43%	52%	45%	29%	36%	50%	28%	25%	58%
	Neither	26%	22%	16%	29%	29%	33%	31%	50%	21%
	Negative	27%	25%	39%	43%	36%	17%	41%	25%	21%
Quality of students as researchers	Positive	43%	50%	37%	29%	25%	51%	28%	29%	65%
	Neither	17%	14%	13%	29%	25%	19%	25%	29%	10%
	Negative	37%	36%	50%	43%	50%	30%	47%	43%	25%
Availability of faculty mentoring	Positive	43%	58%	52%	29%	29%	46%	23%	13%	45%
	Neither	24%	18%	19%	29%	29%	27%	26%	63%	32%
	Negative	30%	24%	29%	43%	43%	27%	52%	25%	23%
Quality of faculty mentoring	Positive	31%	71%	48%	20%	44%	46%	35%	33%	60%
	Neither	12%	9%	19%	40%	22%	29%	29%	17%	20%
	Negative	17%	20%	33%	40%	33%	25%	35%	50%	20%
Interdepartmental politics	Positive	20%	22%	25%	0%	8%	30%	23%	0%	29%
	Neither	35%	40%	32%	50%	33%	39%	33%	78%	43%
	Negative	34%	38%	43%	50%	58%	30%	43%	22%	29%
Managing work-life balance	Positive	18%	18%	20%	14%	18%	19%	6%	22%	35%
	Neither	29%	28%	33%	43%	24%	33%	19%	33%	30%
	Negative	51%	53%	47%	43%	59%	48%	74%	44%	35%

Observations, Conclusions, and Recommendations

This work presents survey data from 266 tenure track or tenured at the associate level faculty on tenure perceptions and impediments. We employed an approach to generate survey data from a broad geographical region and from institutions of various categories as classified by the Carnegie Classification of Institutions. Survey data are presented here without statistical analysis to highlight general clear trends among mechanical engineering faculty only. Work to perform statistical analysis on these data and to combine survey results from Chemical Engineering and Civil/Environmental/Architectural/Construction Engineering is ongoing. We hope that the data, conclusions, and recommendations presented here can be used to facilitate conversations amongst faculty of all career stages regarding the tenure process, requirements/expectations for tenure, and maintaining a work-life balance.

Approximately 50-60% of faculty are provided written guidelines for tenure requirements/expectations (Table 3). Positively, of those provided guidelines, there is a general perception that those guidelines are a true representation of what is necessary to achieve tenure (Table 7). While each program is certainly different, this suggests that departments that do not provide written guidelines may want to consider doing so in the interest of their tenure track faculty. It should also be noted that qualitative survey results suggest most programs do not provide numerical or “hard” requirements for metrics such as external funding and number of publications, as highlighted with the following quotes:

“Enough to demonstrate sustainable research.”

– Tenured faculty member at R1 institution regarding external grant funding

“No specific number of publications mentioned in the guidelines, but a continuous record of publications is expected.”
– Tenure track faculty member at R2 institution regarding number of publications

Faculty amongst all institutions and pre- and post-tenure generally commit ~50-60 hours per week to their career (Figure 2). A lack of distinct differences in these data suggest that broad differences in teaching commitments, research productivity, and service activities that may be observed between institutions and/or departments is not due to simply number of work hours per week. It is more likely that these factors are dictated by a percentage of contractual and actual time (Figures 3 and 4), teaching loads (Table 4), and research expectations (Tables 5 and 6). Specifically, there is a trend as expected for Master’s and Bachelor’s institutions to have a greater teaching load, and for R1 and R2 schools to have expectations for more publications and external grant funding. While availability of student researchers, which is foundationally different for an R1 versus primarily undergraduate institution, may seem as though it would play a role, it was not clearly perceived as a major impediment for faculty at non-research-intensive institutions (Table 9). This may be due to the appropriateness of research expectations between different institutions. As expected, research-intensive institutions

Perceptions of tenure impediments are perhaps not as different between institutions as may have been expected (Table 9). It appears that general trends are similar across many institutional categories, and thus there may be a wide combination of factors that faculty perceive may positively or negatively impact tenure. Thus, we believe that these data suggest perceived impediments are likely program and person specific, and that departments should consider a wide range of support and/or resources for faculty. The observation that approximately 60% of faculty view the expectation of peer-reviewed journal articles as having a positive effect on achieving tenure suggests that this outcome of publishing research efforts, more than any other specific metric, is properly aligned with achieving tenure. One other insightful result from these data (Table 9) is that half of faculty find a conflict between achieving tenure and maintaining a work-life balance. While this may be of no surprise to some, it shows that for many tenure track and recently tenured faculty are sacrificing personal balance for their profession. We hope that these data can spur conversations regarding appropriate work-life balance in various programs across the country.

In summary, these data highlight the similarities and potential differences in time commitments, expectations, and impediments as they relate to tenure across different ABET accredited mechanical engineering programs in the United States. Specific methods to assist tenure track faculty in planning, managing expectations, and developing priorities for the tenure path have been previously published and may be of use to readers [10-12]. One common thread for many “successful” faculty is a network of peers and mentors, which is especially important for those who are pre-tenure [13]. Our survey data of 266 responses range between institution type, tenure track and tenured faculty, and amongst different sub-disciplines. While we have not presented statistical analysis of these data, which is planned in future work, we hope that these observations can encourage conversations regarding tenure expectations and work-life balance in departments around the country.

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