Survey reveals interdisciplinarity of MSE faculty

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For well over 100 years, the current field of materials science and engineering (MSE) has undergone a transformation in its name, content, and character to keep up with the changing needs of our society. From mining to metallurgical engineering to MSE, university departments have constantly faced the challenge of adapting a curriculum that encompasses the past, present, and future of materials. It can be claimed that MSE is more diverse, interdisciplinary, and fickle than any other engineering discipline. This fact helps further the cause of MSE education while complicating it at the same time.

One of the often neglected areas of policy planning and research in MSE is understanding and quantifying the academic background and preparedness of the faculty. Faculty members strongly influence the course design and content within a department. They influence the nature and quality of research, both within their own laboratories and as multidisciplinary, collaborative units within larger organizations. Thus, it is useful for the MSE community to analyze faculty backgrounds and the skill sets they bring to a department in order to meet the challenges of MSE. This article addresses this need.

We looked at 23 large MSE programs within the United States and performed a statistical analysis of 546 faculty members in these institutions. Parameters such as undergraduate (UG) and doctoral degree specializations and institutions were analyzed. Even though no standardized database exists, we used the departmental web pages to extract this information. Some aspects of the analysis results were surprising and some results were as expected. Either way, the report draws a line in the sand for educators and administrators in MSE to make more informed decisions about MSE education in this country.

We first look at the UG degree of faculty members in the 23 MSE departments surveyed. This is shown in Figure 1a. The percentage of faculty members who have a UG degree in MSE is only 28.5%. However, an almost equal number of faculty have a UG in physics (26.7%) while other branches of engineering and chemistry contribute 23.3% and 18%, respectively, to this list. These results are surprising and demonstrate that about 71% of MSE faculty members have UG degrees either in the pure sciences or in other branches of engineering.

When the current faculty are analyzed for their PhD degrees, the trends follow a similar pattern, except now a doctoral degree in MSE accounts for half of the degrees. This is shown in Figure 1b. Physics, chemistry, and engineering follow next and together account for the other half of doctoral degrees for MSE faculty. The combined trends from Figure 1 point to an outflux of people from physics, chemistry, and engineering who chose MSE at the graduate level or as a career in academia. It will be instructive to compare these trends with surveys in other engineering fields such as chemical, electrical, or mechanical engineering.

When faculty UG and PhD degrees are analyzed based on the country granting the degree, the results reveal the continued success of US higher education in attracting talent from the rest of the world. According to Figure 2a and b, about 41% of the MSE faculty members have their UG degree from another nation. However, only 16% of the doctoral degrees are non-US-based. This indicates that within the sample of faculty members analyzed, 25% of non-US–born MSE undergraduates come to the United States to obtain their PhD degrees and stay to join academia. Figure 2c shows the number of PhD graduates from the top 10 institutions who are current MSE faculty members across the United States. Graduates from the Massachusetts Institute of Technology and the University of California–Berkeley combine to account for 21% of the 546 MSE faculty surveyed.

Finally, we look at joint or affiliate appointments of MSE faculty members. From the sample studied, around 35% (190 out of 546 in total) of the faculty

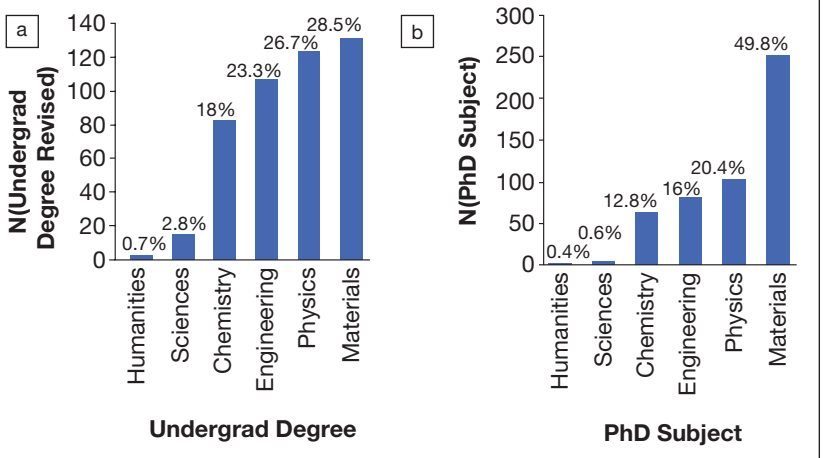

Figure 1. (a) The number of undergraduate (UG) degrees in various broad disciplines of current Materials Science and Engineering (MSE) faculty members across the United States (US); (b) the number of PhD degrees in various broad disciplines of current MSE faculty across the US.

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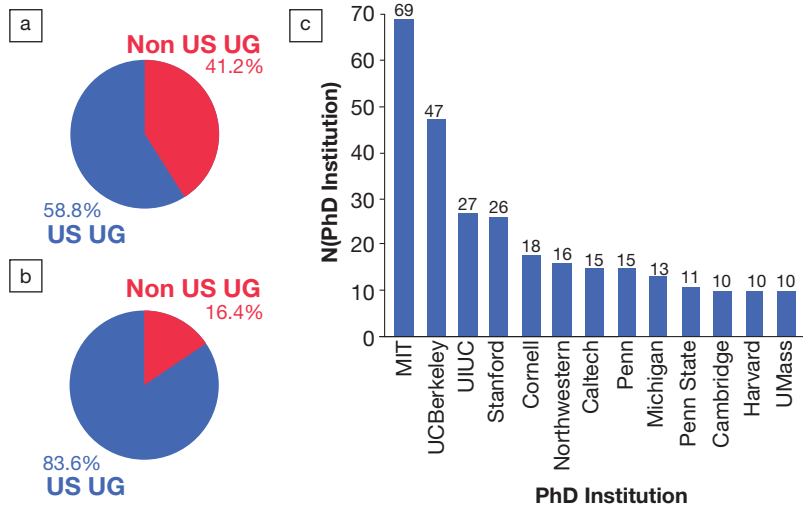

Figure 2. (a) The top pie chart shows the % of MSE faculty with UG degrees from US-based (blue) and non-US–based (red) institutions; (b) the bottom graph does the same analysis for doctoral degrees; (c) the top 10 PhD institutions and the number of doctoral awardees who are current MSE faculty members.

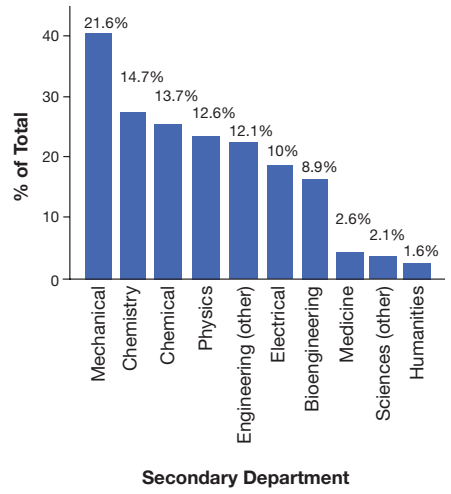

Figure 3. MSE faculty joint/affiliate appointments with other disciplines. The total number of faculty members who have such an appointment is 190 out of a total of 546.

members had joint/affiliate appointments in other departments and schools (Figure 3). A total of 21.6% of the faculty were associated with mechanical engineering. Chemistry, chemical engineering, and physics follow next. Bioengineering and related departments (such as biomedical) have shown recent upswings in joint affiliations as well. Again, it would be instructive to see how other disciplines within engineering fare. Regardless, the data reiterate the interdisciplinary nature of MSE.

The strong hiring numbers of non-MSE graduates in academia create a challenging environment for MSE graduates looking for academic positions. This effect can be termed "academic valving" since it appears to be significantly less likely (though certainly possible) that an MSE graduate would join a physics or chemistry department. Furthermore, questions on curricula design and how MSE can capture the traditional, core ideas rooted in thermodynamics, phase transformations, and kinetics (that are taught in a traditional MSE curricula) and still be able to train students in subjects closely aligned to modern ideas in nanotechnology (such as quantum mechanics, soft matter, and materials modeling) need to be addressed.

Regardless of these challenges, the present analysis certainly points to the highly interdisciplinary nature of MSE research today. MSE has greatly benefited from the fresh infusion of ideas that graduates from Science-Technology-Engineering-Mathematics fields bring to the field. MSE research is more exciting, relevant, and at the forefront of many technological innovations in our society, thanks in large part to the diverse group of extremely talented individuals who chose to enrich MSE with their professional backgrounds and experience.

The full report of the faculty background can be accessed online at http://research.engineering.wustl.edu/~pban/downloads.html/. A Table showing the schools surveyed and the number of faculty members from each MSE department who maintained active academic and biographical data on their web pages can be accessed as Supplementary Material at http://dx.doi.org/TBD.

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