

# PENN STATE

## Department of Mechanical Engineering



# STRATEGIC PLAN

## 2020/2021 – 2025/2026



# Strategic Plan: 2020/2021 – 2025/2026

## Table of Contents

1	Current Status and Context.....	4
1.1	2019/2020 Snapshot – Undergraduate education .....	4
1.2	2019/2020 Snapshot – Graduate education.....	8
1.3	2019/2020 Snapshot – Research .....	10
1.4	2019/2020 Snapshot – Facilities .....	11
1.5	2019/2020 Snapshot – Personnel .....	12
1.6	2019/2020 Snapshot – Governance .....	12
1.7	Strategic objectives for the Pennsylvania State University .....	14
1.8.	Peer institutions.....	14
1.9	Job market .....	16
1.10	Research needs of industry and government.....	17
1.11	Comments on the COVID-19 response .....	19
1.12	Overview of the plan.....	21
2	Mission and vision .....	24
3	Long term strategic objectives.....	24
3.1	Foster a collegial atmosphere in the department.....	24
3.2	Grow the department with diversity and inclusion at the core of each decision .....	24
	Focus on faculty hiring in strategic areas.....	24
	Identify departmental Equity Ambassadors to facilitate diversity and inclusion on committees.....	24
	Continue to improve the graduate student recruiting process to create a vibrant and diverse graduate community.....	24
	Grow the population of high-quality, under-represented groups in the undergraduate, graduate, staff, and faculty populations .....	25
3.3	Continually enhance the scholarly impact and reputation of the department.....	25
	Support research “supergroups” to encourage collaboration, cross-disciplinary research, and graduate student community-building .....	25
	Charge the Research Advancement Committee with promoting the continuous development of faculty research programs and their impact .....	26
	Enhance the scholarship of teaching and learning within the department.....	26



Support formation of research centers and other leadership opportunities for faculty .....	27
Celebrate departmental accomplishments across multiple media formats .....	27
3.4. Drive educational innovation to provide Penn State ME students with a high-quality, modern mechanical engineering education .....	28
Support the “can-do” spirit of Penn State ME students through a curriculum that balances theory with practice and continually exposes students to innovative educational opportunities .....	28
Charge ME Education Innovation Committee to support the continual development of teaching and learning for faculty and staff .....	28
Develop continual improvement of the graduate programs – resident and online ..	28
Provide students meaningful professional, academic, and personal development experiences to encourage lifelong learning .....	29
Reinforce the importance of service to the profession .....	29
3.5 Empower faculty, staff, and students to be leaders at Penn State and beyond .....	30
Support faculty taking leadership positions outside the university .....	30
Provide paths for staff advancement .....	30
Charge Staff Advisory Committee with identifying critical issues for staff .....	30
Encourage faculty to actively participate in university-level institutes .....	30
3.6 Optimize processes, practices, and structures that achieve long-term sustainability, balance due process with agility, and promote accountability to our stakeholders .....	30
Optimize and re-imagine staff positions continuously .....	30
Develop a ME space plan and work with the College of Engineering to identify future space needs .....	30
Develop a ME financial plan to ensure excellence in fiscal stewardship .....	31
Review and revise teaching-load policy .....	31
Evaluate and improve the promotion and tenure process to accommodate increased volume of cases for both faculty and staff workload .....	31
Evaluate and improve the faculty hiring process .....	31
Develop procedures and contingency plans to ensure continued excellence in the department mission in cases of significant disruption to department operations .....	31
3.7 Develop and maintain a supportive culture for continuous improvement that responds to emerging needs .....	31



	Institute two- and four-year reviews of the strategic plan to gauge progress and maintain strategic directions .....	31
	Implement mid-career faculty development program .....	32
4	<b>Implementation plan</b> .....	33

## 1 Current Status and Context

The Penn State Department of Mechanical Engineering embraces a culture of discovery, inclusion, and excellence. Our faculty, 291 graduate, and 661 undergraduate students are innovating today what will impact tomorrow's solutions to meeting our energy needs, homeland security, biomedical devices, and transportation systems<sup>1</sup>. Our program is supported by 57 tenure/tenure-track faculty. This total includes 25 full professors, 9 associate professors, and 23 assistant professors. The department also has 3 non-tenure teaching professors. The College of Engineering has approved an increase to the faculty size to grow to 60 tenure/tenure-track faculty plus 3 tenure/tenure-track partial appointments over the next three years.

### 1.1 2019/2020 Snapshot – Undergraduate education

The Mechanical Engineering (ME) undergraduate program at Penn State is one of the nation's largest and most successful programs. We proudly serve the engineering community by teaching over 16,000 credit hours and offering 34 specialized electives in the ME undergraduate area of study. Our faculty are recognized as leaders in education and actively conduct research to generate new knowledge that strengthens undergraduate and graduate education at Penn State. Our strength in developing and delivering a modern program is directly related to their accomplishments and dedication to the profession. For these reasons and many more, the U.S. News and World Report ranked our undergraduate program 14th in the country for 2020. This success is a direct result of our 2014 strategic planning efforts. In the previous five years we have made many thoughtful changes to our program, but four have been significant in shaping our student's undergraduate education: curriculum modernization, enriched student advising experience, the addition of micro-credentialing workshops, and new undergraduate student lab experience.



**U.S. News  
Rankings 2020**

**UNDERGRADUATE: 12  
GRADUATE: 17**

**Enrollment**

**661**

Undergraduate  
(Jr./Sr.)

**291**

Master's and Ph.D.



**Faculty**

**ME**

Hear from students and alumni by watching the Exposure to Major video series: [bit.ly/PennStateEngineering](https://bit.ly/PennStateEngineering)

<sup>1</sup> <https://www.me.psu.edu/students/undergraduate/index.aspx>





### Curriculum Update

The mechanical engineering curriculum at Penn State has remained relatively unchanged since a time before the internet and modern computation capabilities existed. While the foundation concepts have not changed, the expectations and needs of students and employers alike has. Although many ME core courses include computer assignments on an ad hoc basis, the mechanical engineering curriculum did not provide students with a course on computer modeling or analysis. About one-quarter of our students take our elective finite element course and we did not offer an undergraduate course in computational fluid dynamics. Mechatronics, the integration of mechanical hardware and computer control, was available to students as a technical elective only.

In recent years, our IPAC committee has asked with increasing urgency that we introduce our students to modern, computer-based analysis tools. The expectation in industry today, which ME is not currently meeting, is that any student receiving an undergraduate degree can effectively use modern computational tools and have some familiarity with the control of mechanical systems. After careful study and faculty input, we responded with an updated modern curriculum that promotes student success in the 21st century. In 2017, the ME IPAC committee voted unanimously in favor of a new curriculum that will be available to our students in fall of 2020. The faculty approved the curriculum change in Fall 2017.

# ME Academic Wellness and Career Consultations



## Increased Emphasis on Student Advising

The Mechanical Engineering partnership with Penn State's Counselor Education program was developed out of a need to address issues of retention and career readiness within science, technology, engineering and mathematics (STEM) higher education fields. Research indicates that STEM programs nationwide often experience higher rates of attrition than do many other undergraduate majors, and that there is a shortage of professionals in STEM-related careers. This STEM crisis has also impacted engineering programs within Penn State, as departments are finding that a large percentage of students are eventually switching to non-engineering majors or, for those who do complete their original course of study, are not pursuing STEM-related occupations. Studies further show that STEM students who participate in career development initiatives, such as career counseling, are more likely to maintain their course of study throughout their academic and vocational careers. Dr. Diandra Prescod and master's students in the Counselor Education program have teamed up with Dr. Eric Marsh to provide career counseling services for undergraduate and graduate Penn State students pursuing their degree in ME in order to promote academic and vocational support as well as general student wellness.

The aim of this partnership is to foster greater retention and higher overall success by affording students an opportunity to explore personal and professional matters within a therapeutic setting. Master's students in the career counseling track provide one-on-one counseling to engineering students to address a range of issues, such as managing personal and academic distress, exploring career options, and developing life skills to help with overall wellbeing. ME students are invited to sign-up for 45-minute sessions with one of the career-counseling trainees and can attend an unlimited number of sessions throughout the fall and spring semesters.

## Micro-credentialing Workshops

Micro-credentials offer students and working professionals alike a way to bulk up their resumes with field-specific skills. In an effort to reinforce the importance of lifelong learning for our students the Industrial Professional Advisory Committee (IPAC) suggested the development of micro-credentialing workshops. Alumni from around the country travel to Penn State to share their professional knowledge on topics such as:

- Project Management
- IP Law in Engineering
- Value Engineering

- Finance Concepts for Engineers
- Design for Manufacturing/Design for Cost
- Digital Engineering
- What's really happening with machine learning and artificial intelligence?
- Business Principles for Engineers

Once the students complete the workshop and successfully pass the related test, their information is given to our educational program associate who in turn awards them a digital badge through PSU Badges. This badge can be added to their LinkedIn profile and will help our students share the skills they are building outside of the classroom with potential employers.



### New Student Lab Environment

In Spring 2021, Mechanical Engineering students will be able to register for the department's new lab experience. The vision for our new lab environment is to create a hands-on instructional space that meets the needs of today's engineering education and will facilitate and inspire student creativity. Laboratory instructions will incorporate systems-level experiments that are inquiry-based and support a holistic approach to learning. Fundamental mechanical engineering concepts, including fluid mechanics, heat transfer, material mechanics, control, and dynamics, will be reinforced through real-world topics experiments. These topics will center around modern industrial research and development focus, e.g., sustainability, big data, autonomy & robotics, bioengineering, advanced manufacturing, and energy. Simultaneously, the following skills will be incorporated to prepare students for future careers, experiment design, data acquisition, data analysis, critical thinking, problem-solving, teamwork, presentation, and numerical simulation.



In the current curriculum, mechanical engineering students must complete two lab courses to meet degree requirements. Our program offers 5 ME taught lab courses; ME 315- Heat Transfer, ME 325 - Fluids, ME 355 - Dynamic Systems, and ME 375. During a 2017 lab review, the Curriculum Committee identified alarming enrollment trends and noted that over 90% of our students complete a lab course offered by another department. While the faculty recognized the



value and credibility of this lab, they also recommended that we as a department find out why it is the most popular lab choice of our students.

Further study through student surveys, course evaluations, faculty and external advisory board (IPAC) feedback identified that our lab equipment was not producing reliable results, our experiments needed to be updated, the basement space in the Reber building was not being used to its fullest potential, and that our students preferred more hands on experimentation verses report writing and canned experiments. The data collected guided the exploratory committee to create seven guiding principles for the lab space and course design:

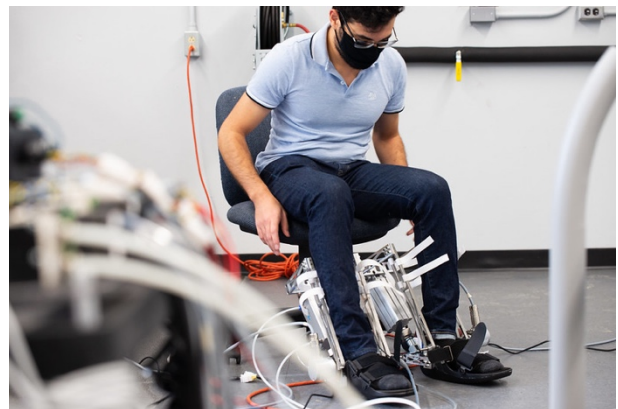
- Multiple apparatuses to maximize interaction and minimize chaos.
- Less cookbook, more exploration.
- Less report writing, more exploration.
- Flexible hardware
- Common data acquisition/micro-controller hardware.
- Students design experiments at least once per course.
- Students compare experiment to simulation where appropriate.

In February 2020, the faculty voted to support a curriculum change that would support this new laboratory experience. In this change, ME 345 (Instrumentation, Measurements, and Statistics – a 4-credit course) would become ME 348 (Circuit Analysis, Instrumentation, and Statistics – a 3-credit course) and the two 1-credit lab requirements would be shifted to the new 3-credit ME senior laboratory experience (ME 350).

As we look forward to the next five years, we will commit to the advancement of learning in Mechanical Engineering in four specific ways; embrace continuous improvement, respond to current and emerging needs of our community, continue to grow our teaching profile, and provide meaningful professional development opportunities to our students. In short, we will dedicate ourselves to the needs of our students. Their success is our success.

## 1.2 2019/2020 Snapshot – Graduate education

The graduate student body currently consists of close of 204 people pursuing their degree full-time on campus at University Park, 55 of which are pursuing master's degrees and 149 of which are working towards their doctorate. In addition, there are 87 students pursuing their graduate studies part-time both on campus at University Park, as well as remotely through the all-online Master of Science (MS) program. At this time, approximately 64% of our graduate students are US citizens while the remaining 36% are International students. Our current gender demographics among the graduate students are



*A graduate student works with an assistive robotic leg in Assistant Professor Anne Martin's lab in September 2020. Credit: Tyler Henderson*

82.8% male and 17.2% female. Across all graduate degree programs, 5.5% of our enrolled students are under-represented minorities.

At the conclusion of the previous academic year (2018 – 2019), 38 master's degrees and 23 PhD degrees were awarded. Of the 61 graduate degrees awarded, 46% were international students and 54% were domestic students. Additionally, 23% of the graduate degrees were earned by Women (9 Masters, 5 PhDs) and 2% were earned by underrepresented minorities (URM; 2 Masters, 0 PhDs).



*A graduate student conducts research in Associate Professor Jackie O'Connor's lab in September 2020.*

*Credit: Tyler Henderson*

There are currently 51 graduate level courses in the total catalog taught by the department, of which 40 are permanent offerings and the remaining 11 are one-semester special-topics courses that have the potential to become permanent offerings in the future. In the 2019/2020 academic year, a total of 26 graduate courses were offered in the Fall semester with 14 of those courses taught at University Park and 12 taught online via World Campus, while 22 graduate courses were offered in the Spring semester with 13 courses taught at University Park and 9 taught via World Campus. Altogether, close to 44% of the graduate courses in 2019/2020 were

offered online via World Campus. In the Fall 2019 semester, the average enrollment in all graduate courses was 12.33 students per course. This was an increase compared to the semester prior (Spring 2019), where the average enrollment was 10.11 students per course.

Recent efforts in the ME Graduate Office have focused on the continued recruitment of top-level graduate students into ME programs. In addition to concerted efforts to recruit externally (both domestically and internationally), a new focus on recruiting internally from our undergraduate students was implemented this past cycle. In the Fall 2019 semester, following the return of the rising seniors to campus, several offers of automatic admission to the graduate program were presented to our top students in an effort to encourage them to consider the continuation of their students towards a master's or doctoral degree. Of the students presented with these offers, 35% accepted and will begin their graduate studies in the Fall 2020 semester.

Per the most recent U.S. News & World Report, the Mechanical Engineering department is ranked 17<sup>th</sup> in the United States.



**\$29.5**  
[ MILLION ]

## **2019-20 Research Expenditures**

Research expenditures include subcontracts and internally funded projects.

### 1.3 2019/2020 Snapshot – Research

The research program in the Department of Mechanical Engineering is healthy and growing. In addition to 51 academic faculty, the department is home to 11 research faculty, 7 post-doctoral researchers, 3 non-faculty researchers, and 4 visiting researchers in the 2019/2020 school year. During this time, the total research expenditures in mechanical engineering were \$29,521,061; this expenditure includes contributions from the Applied Research Laboratory in the discipline of Mechanical Engineering. Within the department, funding includes ~52% from federal sources, ~17% from industry sources, ~31% from state and local sources, and ~0.1% from gift funds. The majority of the state and local funding takes the form of start-up packages, provided from university, college, and department funds. The federal sources are numerous, with the largest shares coming from the U.S. Department of Energy, the National Science Foundation, and the Air Force Office of Scientific Research; the other branches of the military, national labs, and the National Institutes of Health each make up relatively small contributions to the overall funding portfolio. In addition to normal grants and contracts, early-career faculty are regularly awarded prestigious early-career grants, including two NSF CAREER (Guha Manogharan and Anne Martin) and one AFOSR Young Investigator (Jean-Michel Mongeau) grants in the 2019/2020 school year.

A survey of faculty research shows strengths in five broad research areas: thermal systems; energy, transportation, and environmental systems; biodevices and health; smart materials; and advanced manufacturing and design. A wide range of experimental, computational, and theoretical research is ongoing in each of these areas. These areas align well with the strategic research thrusts of the university, which include topics such as Enhancing Health, Stewarding Our Planet's Resources, and Empowering Through Digital Innovation. These research areas also align with government funding priorities, as discussed in Section 1.10. Given the close alignment between ME research and university research priorities, ME faculty are highly involved in research institutes across campus. Members of the faculty are affiliated with the Materials Research Institute (~20 faculty), the Institutes for Energy and the Environment (~20 faculty), and the Institute for Computational and Data Sciences (~15 faculty).

In the 2019/2020 school year, three new centers were formed from the ME department: the Center for Biodevices (led by Mary Frecker), the Center for Gas Turbine Research, Education, and Outreach (led by Jacqueline O'Connor), and the Convergence Center for Living

Multifunctional Material Systems (led by Zoubeida Ounaies). These centers will greatly enhance the profile of research within the department both within the university and outside. In addition to their research mission, the centers also have a significant educational mission and will involve both graduate and undergraduate students in their activities.

#### 1.4 2019/2020 Snapshot – Facilities

The Penn State College of Engineering brick and mortar footprint is rapidly evolving. In 2019, the College of Engineering published its plans for an initial five-year phase of the plan. The total estimated cost for phase-one design, construction, renovation, and demolition is projected at \$370 million. The initial plan includes two new buildings that will serve as anchors to a new central engineering hub to the west of North Atherton Street, adding 377,000 gross square feet to the college's infrastructure. Phase I, which is projected to conclude in 2023, also includes proposed renovations to Sackett Building and the demolition of Hammond Building along College Avenue and the Engineering Units behind Hammond. At this time, mechanical engineering is not allocated any new or additional space. According to data collected from departmental administration, the ME allocation of space will decrease, while at the same time the ME department faculty numbers are projected to grow. This is alarming but the entire College of Engineering building plan is not finished. Phase I planning has been completed, but decisions on Phase II is not finished. ME will establish a Facilities Committee that will create a five-year plan on what is needed and communicate this to the College of Engineering. Despite these facilities challenges, ME will continue to be innovative with its space usage including some of the methods discussed in this strategic plan which encompass teaching, research and service to the mechanical engineering discipline.

#### Facilities for Teaching

Mechanical engineering faculty continue to innovate through various teaching venues and mediums. Resident ME classes were taught in approximately 23 different buildings across the University Park campus in the Spring 2020 semester. Many instructors teach both resident and online classes through the World Campus (WC) and for some courses, instructors now have more WC students in their online section than resident students. A mantra that is becoming popular with some faculty, especially reinforced with the 2020 COVID-19 pandemic, includes "Learn Anywhere." We want to remove any limitations that geographical barriers pose to students learning. ME instructors have the vision to deliver course material anywhere, anytime, which for many courses requires specialized tools, such as advanced computing resources. In the past, the IPAC recommendations led us to create new



*Credit: Penn State College of Engineering*





courses in computational tools and a complete redesign of many of the laboratory courses. With the redesign of the Reber basement for ME laboratories courses underway, as well as the creation of the e-Knowledge Commons, resources are highlighted to visitors and students about our investment in these areas. However, showcasing our computational strengths could improve. The ME department want to highlight the computing resources that they use in their research as well as in their courses. Stakeholders should get the impression that ME is the place for training, research and application of advanced computational methods. This can be accomplished by adding banners or signs at various locations of the ME footprint.

#### Facilities for Service to the Discipline

The ME department will continue to support student team/clubs that have little space. While the department has reduced support for student groups over last 5 years, faculty see the need to strengthen programs that enhance professional skills. Foremost is the American Society of Mechanical Engineering (ASME) who is the key professional organization for our discipline. Currently the ASME student group was two small rooms. Faculty hope to expand this in the future.

#### 1.5 2019/2020 Snapshot – Personnel

In the 2019/2020 school year, the ME department had 51 tenure-line faculty (25 professors, 6 associate professors, and 20 assistant professors), 3 non-tenure-line faculty, 11 research faculty, and 21 staff members. This year, 7 openings for tenure-line faculty were available in an open call for all research areas and all ranks. From that search, 5 ME faculty and 1 inter-disciplinary faculty (as part of a college-level search) were hired and will be starting in the 2020/2021 school year.

#### 1.6 2019/2020 Snapshot – Governance

The department has a department head (Dr. Karen Thole) and is led by an executive team, which consists of the associate department head for administration (Dr. Zoubeida Ounaies), the associate department head for graduate studies (Dr. Daniel Haworth), the associate department head for undergraduate studies (Dr. Eric Marsh), the business and operations director (Tom Houck), and the chair of the promotion and tenure committee (Dr. Daniel Haworth). Currently, the department head is responsible for choosing the associate department heads and the chair of the promotion and tenure committee is elected by the faculty. There are four functional units that support the department, including the finance office, the graduate office, the undergraduate office, and IT staff. Additionally, the department has 21 administrative staff that support a variety of department functions.

The educational and research missions of the department are supported by the following committees:

- **Promotion and Tenure Committee:** Consists of five full professors, two associate professors, and two alternates (one full, one associate professor), all of whom are elected by the tenure-line faculty. Committee is responsible for reviewing promotion



and tenure cases, working with faculty members under review on dossier preparation, and performing peer teaching evaluations.

- **Non-tenure line promotion committee:** Committee is responsible for supporting the promotion progress of non-tenure line faculty in the department.
- **Strategic Planning Committee (new to 2019/2020):** The committee responsible for this document – see Section 1 for details of its operation.
- **ME Operations Committee:** Responsible for writing and maintaining the department operations manual.
- **ME Honors and Awards Committee:** Previously the responsibility of the promotion and tenure committee, faculty and staff honors and awards are now handled by this committee. The committee is responsible for identifying and nominating department individuals for awards both within Penn State and outside the university, where applicable.
- **ME Educational Innovation Committee:** The committee is responsible for and ensures adherence of academic year course caucus guidelines, curricular review, continuous improvement development and implementation.
- **ME Winterfest Committee:** The committee responsible for planning the yearly department Winterfest celebration for faculty, staff, and graduate students.
- **Faculty Search Committee:** The committee responsible for reviewing faculty applications. The committee structure includes topical sub-committees, each of which has a chair. The topical sub-committees for the 2019/2020 year were: thermal sciences, mechanical sciences, and the co-hire with the Institute for Computational and Data Science. ME also had two representatives on the college's search committee for hires in energy systems. The chairs of each of these sub-committees formed the oversight committee, chaired by the associate department head of administration (Dr. Zoubeida Ounaies).
- **Career Advancement Implementation Committee (new to 2019/2020):** This committee was formed to enact the recommendations of the 2018/2019 ME Mentoring Committee regarding a mid-career faculty development program.
- **ME Research Advancement Committee:** This committee was formed to advance the research enterprise of the department.
- **Seminars and Graduate Policy Committee:** This committee oversees the operation of graduate programs in the department. That includes establishing and reviewing admission standards, curricular matters, and qualifying exams. The committee also reviews and ranks nominations for our endowed seminar series.
- **Graduate Admissions Committee:** This committee is responsible for reviewing graduate applications for both the ME and Advanced Manufacturing and Design degree programs.
- **ME Qualifying Exam Committees:** These committees write and administer the Ph.D. qualifying exams during the fall and spring semesters.

- **ME Graduate Student Recruitment and Support Committee:** The intent of this committee is to work with the graduate programs office to enhance recruitment and retention of graduate students.
- **Undergraduate Lab Improvement (new to 2019/2020):** This committee is charged with revamping the current laboratory curriculum, condensing four one-credit lab courses and the re-designed ME348 into a cohesive 3-credit laboratory course.
- **Schreyer Honors Advising:** This committee is comprised of the six Schreyer honors advisors in the department and is responsible for developing and maintaining procedures regarding honors degrees within ME. The chair of this committee serves as the point of contact between ME and the Schreyer Honors College.

Finally, the required courses are supported by course caucuses, whose responsibility it is to ensure consistency between sections of courses and that each course is implementing ABET standards and improvements.

### 1.7 Strategic objectives for the Pennsylvania State University

Penn State as a university has developed a macro strategic plan to guide efforts from 2016-2025. The foundational themes embedded within this plan are: “Enabling Access to Education”, “Engaging Our Students”, “Advancing Inclusion, Equity, and Diversity”, “Enhancing Global Engagement”, “Driving Economic Development”, and “Ensuring a Sustainable Future”. In the mechanical engineering department, we are positioned to contribute to all of these objectives.



Credit: Penn State College of Engineering

### 1.8 Peer institutions

The Department of Mechanical Engineering benchmarks itself against ME departments in a set of peer institutions referred to as the “Big10+” and includes the following universities: University of California at Berkeley, Carnegie Mellon, Cornell, Georgia Institute of Technology, University of Illinois Urbana-Champaign, Iowa State University, University of Maryland, University of Michigan, University of Minnesota, Massachusetts Institute of Technology, University of Nebraska, Northwestern University, Ohio State University, Purdue University, Rutgers University, Stanford University, University of Texas – Austin, and University of Wisconsin. Yearly meetings of leadership from ME departments at each of these universities allow for comparison of a number of metrics, including: number and types of faculty, faculty hiring, teaching load, degrees granted, student demographics, student enrollments, research funding, departmental support, and

space. This section provides a brief overview of these comparisons in the 2018/2019 school year, which was the data available during the development of this plan.

As a point of comparison, we may reference performance metrics and other relevant attributes of peer institutions. These parameters are listed in

Table 1. Our program typically falls within the bounds of these peer institutions, and in several performance areas we exceed our peers. However, some noteworthy outliers should be mentioned. As discussed elsewhere, our faculty skews disproportionately toward assistant professors due to the recent spate of hiring. As these faculty proceed through the tenure process to become associate professors, our distribution will begin to resemble those of our peers. Another notable departure from our peers is in the size of our graduate program, especially when compared to our undergraduate program.

**Table 1. Department and program statistics from Penn State and the Big10+. Data for both PSU ME and peer institutions are from 2018 – 2019, the most recent year for which data are available. Error marked is standard error. Noteworthy departures from peer institutions are bolded.**

	Penn State ME	Peer Institutions
<i>Faculty size/distribution</i>		
Total FTE [Assist/Assoc/Full] %	51 [ <b>43</b> / 4 / 51] %	45.9 ± 4.4 [ <b>23</b> / 21 / 56]
Faculty hired '18-'19	2	±2%
<b>Contract research faculty</b>	<b>11</b>	2.3 ± 0.3
Contract teaching faculty	2	<b>3.2</b> ± 1.5
		3.8 ± 0.7
<i>Faculty teaching load (semesters/year)</i>		
<b>Research (salary recovery)</b>	2.5	1.9 ± 0.1
Research (no salary recovery)	3	2.6 ± 0.2
Non-research	4	4.3 ± 0.3
<i>Research expenditures (per faculty, in thousands of dollars/year)</i>		
<b>Government</b>	364.0	283.3 ± 30.6
State	182.6	28.4 ± 11.9
Private	46.1	84.4 ± 16.8



Other	0	70.8 ± 15.6
Overhead rate	60%	56 ± 1%

*Allocated research space per faculty (square feet)*

(Mean)	2,201	2,341 ± 149
--------	-------	-------------

*Undergraduate course sizes*

<b>Statics and Dynamics</b>	228	154 ± 24
Systems	101	111 ± 10
Thermodynamics	90	101 ± 11
Heat Transfer	77	85 ± 9
(all core courses)	124	113 ± 10

*Student enrollment (per faculty)*

<b>BS</b>	788    15.5	840 ± 106    18.8 ± 1.8
<b>MS</b>	46    0.9	105 ± 17    2.4 ± 0.5
<b>PhD</b>	156    3.1	177 ± 22    3.8 ± 0.4

*Demographics and representation (% female / % underrepresented minority)*

<b>Faculty</b>	22 / 3.4 %	15 ± 2 / 8 ± 2%
Undergraduate	16 / 4%	20 ± 2 / 6 ± 2%
<b>Graduate</b>	14.5 / 4.5%	22 ± 3 / 13 ± 2%

*Degrees awarded (per faculty per year)*

<b>BS</b>	9.79	5.63 ± 0.61
<b>MS</b>	0.93	2.11 ± 0.39
<b>PhD</b>	0.51	0.84 ± 0.21

### 1.9 Job market

As of September 2019, data from the Bureau of Labor Statistics (BLS) suggests that mechanical engineering will see ~4% growth, on par with the broader job market (5%) and engineering overall (5%). However, that growth varies greatly by industry: manufacturing is expected to remain neutral (save for hybrid and electric vehicles) whereas declines in certain



industries will temper growth. These declining industries, by percentage of the industry, include telecommunications; printing and related support activities; textile mills and textile products; and iron and steel mills, to highlight a few key areas. Key advancing areas by percent of their own industry include non-store retailers, retail trade, and computer systems design, to highlight a few key areas.

Within Pennsylvania, mechanical engineers are expected to earn a mean annual wage of \$85.7k, placing Pennsylvania near the 50th percentile among other states. However, Pennsylvania reports roughly 30% more mechanical engineering jobs than the average state in the US. Overall, job prospects for mechanical engineers are expected to be good.

Mechanical engineers hold approximately 312,900 jobs currently in the US. The top employers of mechanical engineers are listed in Table 2. When analyzed by industry, manufacturing accounts for 48.5% of all mechanical engineers employed. Data from direct surveys of employers shows that skills in demand include computational design and simulation; and three-dimensional printing.

**Table 2. Top Employers of Mechanical Engineers in the US Labor Market [BLS]**

Architectural, engineering, and related services	20%
Machinery Manufacturing	14%
Transportation equipment manufacturing	11%
Computer and electronic product manufacturing	7%
Scientific research and development services	6%

Undergraduate students from Penn State Mechanical Engineering take on a range of jobs across a variety of firms. Penn State ME graduates can be found in Fortune 500 companies such as Exelon, Accenture, Boeing, Cummins, General Motors, Ford Motor Company, Shell Oil Company, Lockheed, and Ingersoll Rand to name only a few. In addition to large multinational corporations, Penn State ME graduates also find employment in smaller Pennsylvania based firms such as Monroe Energy, though less frequently. As per BLS trends, undergraduate employment favors manufacturing and transportation industries, with the construction and the energy sector also well represented. Job titles suggest an emphasis on project management; testing and safety; and design.

#### 1.10 Research needs of industry and government

Research funding for the department is primarily supported by the federal government with the National Science Foundation (NSF), Department of Energy (DOE), and the Department of Defense (DOD) providing most of the support. This section surveys the current research needs of seven federal agencies to provide a research focus snapshot to help guide future research directions within the department, faculty hires, and strategic investments.

The websites of NSF CBET and CMMI divisions, ONR, ARPA-e, ARO, AFOSR, and FAA were crawled to extract descriptions of core research programs. The descriptions were then preprocessed, filtered, and fed through Matlab wordcloud.m to produce word clouds and the

list of top 100 words. The top 100 words were then broken into nine categories (Systems & Control, Energy, Modeling, Computation, & Data, Sensors & Electronics, Environmental, Design & Structures, Materials & Manufacturing, Thermal & Fluids, and Autonomy. Figure 1 shows a word cloud from ONR and the associated list of top 100 words. The ONR word cloud shows an emphasis on systems and control, sensors and electronics, and autonomy.

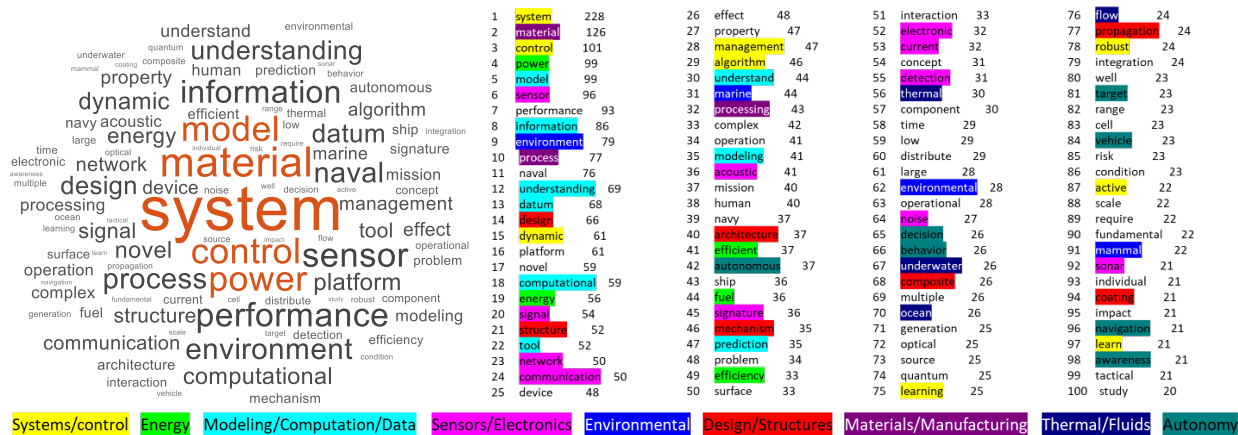


Figure 1. ONR word cloud and categorized list of top 100 words.

The compiled and summarized results for all seven agencies are shown in

Table 3. The topic of systems and control has broad support across all the agencies with the highest rating from ONR. Energy is highly concentrated in ARPA-e with little mention in most of the other agencies. Modeling, computation, and data was emphasized in the DOD and had a high overall citation rate. Sensors and electronics were mentioned by DOD agencies as well. Environmental terms appeared most in NSF CBET and ARPA-e. Structures and Design had the highest overall number of mentions with most in NSF CMMI. Materials and manufacturing were mentioned most frequently in NSF CBET were thermal and fluid terms. Autonomy was uniformly mentioned across most agencies.



Table 3. Summary of Agency Mentions of ME Research Areas

AGENCY	RESEARCH AREAS								
	Systems & Control	Energy	Modeling, Computation & Data	Sensors & Electronics	Environmental	Design & Structures	Materials & Manufacturing	Thermal & Fluid	Autonomy
NSF CBET	4	3	2	5	15	6	10	9	0
NSF CMMI	7	0	6	1	6	16	6	0	5
ONR	9	5	9	11	4	7	3	4	7
ARPA-e	6	23	2	0	12	5	2	2	0
ARO	4	2	12	3	0	6	4	0	7
AFOSR	5	3	16	5	0	7	5	7	1
FAA	5	3	3	4	7	4	0	4	3
<b>TOTAL</b>	<b>40</b>	<b>39</b>	<b>50</b>	<b>29</b>	<b>44</b>	<b>51</b>	<b>30</b>	<b>26</b>	<b>23</b>

#### 1.11 Comments on the COVID-19 response

On March 11, 2020, the University announced an interruption to in-person instruction as a result of the COVID-19 pandemic. Initially slated for three weeks, the cancellation of in-person instruction was extended on March 18, 2020 and online instruction took place for the remainder of the Spring 2020 semester. After the initial announcement, the university followed guidance from the state of Pennsylvania and the federal government on best practices for social distancing, resulting in cancellation of in-person meetings, shutting down of non-essential laboratory

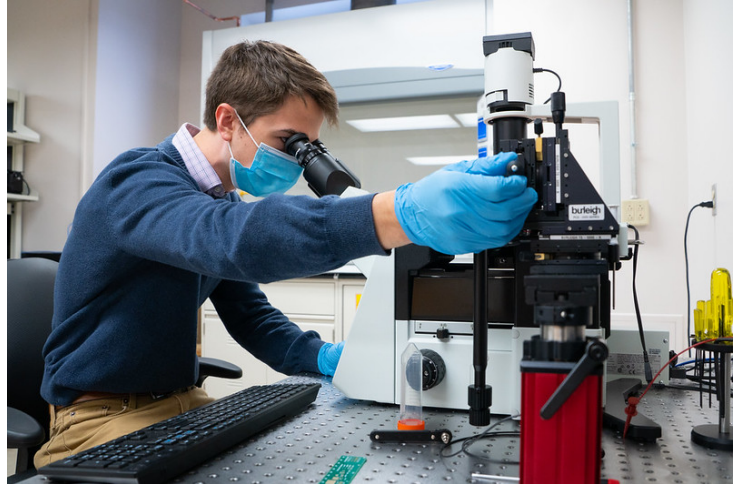


activities, cancellation of all travel (domestic and international), and a significant change to all operations of the university. Faculty, staff, and students moved all operations to their homes, requiring a rapid conversion to online learning, working, and communicating.

Following the initial announcement on remote instruction, the Dean of the College of Engineering formed a Corona Crisis Team as a communication channel for students, staff, and faculty. The site housed important information relating to student housing, IT resources, academic support, and especially helpful for our faculty a link to curated tools, resources, and tutorials to help continue teaching through the campus closures. The ME department supported our faculty's transition to online learning through surveys to identify equipment shortages and transition needs. ME IT technicians quickly filled support needs and three workshops were developed and hosted through the METLI initiative by the Director of Online Pedagogy and Credentialing, to share online teaching best practices and alternative assessment methods.

Within the first week of distance learning several steps were taken to help ease our students transition to their new learning environment. The university registrar office identified accounts that were not accessing the LMS and distributed the information to the responsible department for assistance. The ME department created a virtual advising platform for academic and wellness advising to assist students with their transition to online learning, scheduling, and mental health needs. The Department also created an undergraduate and graduate student survey determine how they were adjusting to remote instruction. Student town hall meetings were held every two weeks to communicate important information, answer questions, and listen to our student's concerns. The University instituted an Optional Alternative Grading (OAG) Policy for Undergraduate Students. Under the policy, faculty determine and file grades according to existing policies, students then have ten days to decide whether to convert a given grade to Satisfactory, Pass, or No Grade. To assist students with decision on use of OAG, the University created a special GPA calculator and our department encouraged students to talk with their academic advisors.

The graduate office took steps to support graduate education during this time. All graduate comprehensive exams and thesis defenses were moved online. Bi-weekly townhall meetings hosted by the graduate office for all graduate students in the program provided students an opportunity to hear updates and have questions answered. Graduate recruiting efforts also moved online, although the accepted graduate students visit day was fortunately held in early February and so did not need to be cancelled. Students who were not able to make that visit



*A graduate student safely works in Assistant Professor Joseph Najem's laboratory in September 2020. Credit: Tyler Henderson*

and were instead scheduled to visit the school in March and April were directed to contact faculty separately and recruiting moved to virtual meetings. Finally, extended deadlines and other accommodations were made for the incoming Fall 2020 students to insure a robust incoming graduate class.



*Dr. Neerav Goyal, a physician at the Milton S. Hershey Medical Center, tests out a 3D-printed filtration mask prototype designed by MASC. Credit: Jason Plotkin*

Despite the closure of many of the department's research labs, ME faculty, students, and staff led significant efforts in a university-wide initiative, Manufacturing and Sterilization for COVID-19 (MASC), to design and fabricate personal protective equipment (PPE) and other medical necessities for first responders. Efforts related to additive manufacturing, rapid prototyping and design, and biodevices coordinated with doctors and researchers at Penn State Health Milton S. Hershey Medical Center and the Penn State College of Medicine to implement these solutions.

In continuing to carry out its educational, research, and service missions, the department was most of all focused on supporting its community. Faculty were kept up to date with changes to policies for teaching, promotion and tenure, and research through frequent emails and faculty meetings. The shift to remote teaching and restricted access to facilities on campus led to significant challenges for faculty in delivering quality instructional experiences and in continuing their research and service. In recognition of these challenge and in consort with Faculty Senate, the University instituted an optional one-year tenure extension for all pre-tenure faculty, and it restricted the use of Student Ratings of Teaching Effectiveness to formative purposes only.

### 1.12 Overview of the plan

A strategic planning committee, comprised of faculty and staff, were convened in August 2019 to develop the strategic plan for the next five years. Members of the committee included: Jacqueline O'Connor (chair, associate professor), Margaret Byron (assistant professor), Brian Foley (assistant professor), Erin Hendrick (communications strategist), Tom Houck (business and operations director), Reuben Kraft (associate professor), Angela Lesko (educational program associate), Chris Rahn (professor and associate dean for innovation at the college of engineering), and Paris von Lockette (professor); the committee was aided by Mandy Engel-Herbert (administrative assistant).

Over the course of the fall and spring semesters, the committee collected information on the current status of the department, views from key stakeholders, and information about the climate

in which the department operates, including trends in research funding, student hiring, and industry needs. In particular, a number of stakeholders were directly contacted in order to solicit important views on the operations of the department. These efforts included:

- Workshops with faculty (August 2019 and January 2020)
- A staff web survey (September 2019)
- Interviews with directors of the Institutes for Energy and the Environment (Tom Richard), Materials Research Institute (Clive Randall), and the Institute for Computational and Data Science (Jenni Evans), as well as associate vice president for research (Shashank Priya)
- Web survey of graduate students (November-December 2019)
- Focus groups with: graduate students, undergraduate office faculty/staff, graduate office faculty/staff, professors who run laboratories (Fall 2019)
- Feedback session with the Industrial and Professional Advisory Council (IPAC) (Spring 2020)

Data from these collection efforts were then organized into a mission and vision statement as well as a set of seven strategic objectives, each with a number of sub-goals. This document outlines the results of this process. While this pandemic has changed the way in which the department operates, it did not change our dedication to our core mission. The strategic plan was largely developed ahead of the spread of COVID-19 to the United States, but was revised to incorporate the need for agility and preparedness that future challenges like this may require.

The strategic plan was written to support the department's strengths and address its current weaknesses to ensure continued improvement during the plan's five-year lifetime. This department's greatest strength is its culture and sense of community. At the heart of everything we do is the people who do it, and the foundation of the success of the department is built on the hard work and dedication of the faculty, staff, and students of ME. Penn State Mechanical Engineering people are "do-ers" – from students, to staff, to faculty, the people of ME are creative problem solvers who jump at the chance to get involved and make a difference. This department culture makes us unique both at the university and among our peer institutions, and we are proud to be known for this culture.

Building from this foundational strength, we offer a modern and continually improving undergraduate education that marries theory, hands-on experiences, and practical knowledge to provide undergraduate students with the knowledge and skills they need to become lifelong learners and successful engineers. Our graduate education provides students rigorous and flexible academic offerings in conjunction with world-class research opportunities for resident M.S., online M.S., and resident Ph.D. degrees. Our highly productive research enterprise achieves the university's commitment to impact, addressing important issues regarding health, energy, sustainability, manufacturing, and many more. Our robust research portfolio includes significant support from federal, state, and industry sources, and has supported the formation of a number of research centers. Finally, the operations of our department are strong and agile, as evidenced by the department's rapid response to the COVID-19 crisis.

Despite the current success of the department, there are a number of areas that have been identified for improvement. In undergraduate education, we identified the need for better

utilization of the course caucuses and growth in the offerings of important career skills, including both technical and non-technical skills. Feedback from graduate students of both the resident and online programs indicated that the department must foster a better sense of community for the graduate population. Given the somewhat individual nature of graduate research and the unfortunate physical distance between different laboratories within the department, resident graduate students have indicated that the lack of community has implications for both mental health as well as their educational development. Online students indicated that they appreciate the effort that faculty make in their blended resident/online classes to include the online students as much as possible in the resident experience, and they would like to see this extended to more of the graduate school experience as well.



*Associate Professor Paris von Lockette and Professor Zoubeida Ounaies work with graduate students in 2019.  
Credit: Erin Cassidy Hendrick*

In research, the department should continue to grow in strategic areas, supporting both new and current faculty to expand their research programs in new and exciting directions. As part of this, the department should diversify its funding sources. Currently most funding comes from the Department of Energy, the National Science Foundation, and the Air Force Office of Scientific Research; the department should expand into other branches of the military, the National Institutes of Health, and other agencies that complement the wide variety of research on-going in the department. Further, the department should enhance its ties with

industry to grow the portion of industrial research.

Operationally, the department should continue to support the development of all individuals – faculty, staff, and students. Further, given the recent growth in the department and cyclic nature of strategic planning, we recommend that the department evaluate three of its core functions – faculty hiring, the teaching policy, and the promotion and tenure process – to ensure optimal efficacy for a growing and dynamic department.

The strategic plan speaks directly to these strengths and weaknesses, proposing strategies by which to support our strengths and address the weaknesses in seven long-term strategic objectives. Each strategic objective addresses multiple areas of department operation and sub-goals are used to highlight particularly important actions to achieve each of the objectives. The implementation plan provides a timeline and prioritization of each of the objectives, based on feedback from department faculty and staff.



## 2 Mission and vision

**Vision:** Building people and ideas for impact

**Mission:** Create a diverse and inclusive community that empowers excellence in research, education, and service

## 3 Long term strategic objectives

### 3.1 *Foster a collegial atmosphere in the department*

A key reason for the ME department's success is the collegial and supportive atmosphere that is fostered by the faculty, staff, and students. Our community also extends beyond the students, faculty, and staff, and includes alumni, visiting researchers and post-doctoral scholars, donors, and our industrial review board. All members of the ME community must work to maintain this environment in every activity we do and to promote engagement among all members of the community. As such, it is the first and most foundational strategic objective for the department as it supports the success of every other objective we outline.

### 3.2 *Grow the department with diversity and inclusion at the core of each decision*

#### *Focus on faculty hiring in strategic areas*

Given the trends in research funding and needs from stakeholders, outlined in Section 1, we will focus faculty hiring in the following strategic areas in addition to maintaining expertise in current fields:

- Advanced diagnostics and controls for extreme environments
- Materials for high-temperature thermal systems and harsh environments
- Advanced data methods for engineering problems
- Energy systems and storage, interface between energy and environmental systems
- Digital health
- Sensing and IoT in advanced manufacturing

#### *Identify departmental Equity Ambassadors to facilitate diversity and inclusion initiatives*

To support the strategic objective of growing the department with diversity and inclusion at the core of each decision, and to ensure that all other operations of the department proceed equitably, the department will identify Equity Ambassadors within the faculty. These Equity Ambassadors will receive additional training in issues related to diversity, inclusion, and equity and serve on committees to ensure that these principles are being applied in departmental decisions. Equity Ambassadors will lead reviews of certain departmental processes to identify areas of improvement for promoting issues of equity and inclusion.

#### *Continue to improve the graduate student recruiting process to create a vibrant and diverse graduate community*

The ME department has put significant effort into improving graduate student recruiting practices. With the addition of a re-imagined staff position in the graduate office and offers being



made to top PSU ME undergraduate students, the recruiting success rate should rise. We encourage the department to continue to support these efforts and develop new practices that seek to improve recruitment of top students. This effort includes recruitment for both the resident and online programs.

*Grow the population of high-quality, under-represented groups in the undergraduate, graduate, staff, and faculty populations*

A healthy, creative, and successful department community relies on a diversity of voices and viewpoints from faculty, staff, and students. The department will work to grow the population of high-quality under-represented groups in the entire community. Strategies should include programs like “It’s All About ME,” collaboration with professional societies for under-represented populations, and enhancement of our online presence to emphasize our commitment to diversity. At the undergraduate level, better messaging and outreach to incoming students will specifically target women and under-represented minorities. Improved graduate recruiting practices will cater to top applicants from diverse backgrounds in order to grow the pool of potential students. Faculty hiring committees with training in recruiting diverse candidates will use personal and professional networks to diversify the applicant pool. Creativity in staffing and support for staff members will also enhance staff diversity. Yearly training on implicit bias and diversity issues should be implemented for faculty and staff in order to support this goal; similar training topics should be incorporated in the undergraduate advising course (ME 390/490) and graduate student seminar (ME 590) on a yearly basis.



*A group of faculty and students gather for a women's mentoring lunch in November 2019. Credit: Erin Cassidy Hendrick*

3.3 Continually enhance the scholarly impact and reputation of the department

*Support research “supergroups” to encourage collaboration, cross-disciplinary research, and graduate student community-building*

In an effort to create greater community around interdisciplinary and collaborative research within the department, the department should support the period formation of research “supergroups.” Supergroups are fluid and inclusive groupings of researchers that emerge out of research needs and ideas, bringing together faculty and graduate students to nurture collaboration on intersectional topics. These evolving structures will exist as needed and be supported through a range of events – brainstorming sessions, poster sessions, graduate student mixers, seminars, and more – to support the development of research ideas within the

department. One potential mechanism for seeding supergroup formation will be the establishment of several cross-cutting, interdisciplinary themes of research each semester, proposed by faculty to the Research Advancement Committee and chosen by that same committee. These themes should reach a diverse number of faculty and support a number of events that allow for greater collaboration and idea creation for proposals, centers, and more. The ultimate goal of these supergroups is to support a culture of collaboration and research community within the department to support faculty, researchers, and graduate students.

*Charge the Research Advancement Committee with promoting the continuous development of faculty research programs and their impact*

The Research Advancement Committee will be charged with supporting the research enterprise within the department in four main thrusts. First, the committee will undertake more detailed data collection regarding research funding trends and disseminate this information to the faculty. Data will be used to enhance knowledge of funding trends to support more successful proposals and to diversify the funding sources for faculty in the department. Second, the committee will work to enhance ties between the department and industry in order to enable all faculty, but particularly early-career faculty, opportunities to enhance the impact of their



Anne Martin, the Martin W. Trethewey Early Career Professor, and Bo Cheng, the Kenneth K. and Olivia J. Kuo Early Career Professor work in the Gait Optimization (GO) Lab in 2019. Credit: Tyler Henderson

research. These industry relationships will also help the department identify future engineering research needs. Third, liaisons between the department and the institutes, like IEE, MRI, ICDS, as well as the office of the vice president for research will be identified from the research advancement committee in order to better communicate opportunities to ME faculty and highlight the work happening in ME at a university level. Finally, the committee will support continuing education for current faculty allowing them to update skillsets and enhance the research productivity of the department. For example, training current faculty in advanced data

science methods like machine learning, in conjunction with targeted hiring in this area, would accelerate the pace of research.

*Enhance the scholarship of teaching and learning within the department*

The scholarship of teaching and learning (SOTL) is an integral part of any university's mission. In order to further distinguish itself in both research and educational outcomes, the ME department should enhance its support for the SOTL in a number of ways. First, support the current and continue to identify top tenure- and non-tenure-line faculty in this area of research. Second, better support the inclusion of SOTL outcomes in technical proposals, particularly early-career awards like NSF-CAREER and DOE Early Career. Finally, leverage the research performed

in this area for continuous improvement of the undergraduate and graduate programs, as well as outreach to alumni, and publish the outcomes of these initiatives where appropriate.

*Support formation of research centers and other leadership opportunities for faculty*

The recent formation of three research centers with leaders in the ME department – Convergence Center for Living Multifunctional Material Systems (director: Zoubeida Ounaies), Center for Biodevices (director: Mary Frecker), and the Center for Gas Turbine Research, Education, and Outreach (director: Jacqueline O'Connor) – have raised the profile of research from the department. Given the vast multidisciplinary expertise in ME, the department will support the formation of more centers. Additionally, the department will encourage ME faculty to take leadership roles in current institutes and centers on campus.



Jackie O'Connor, associate professor, Mary Frecker, the Riess Chair in Engineering, and Zoubeida Ounaies, professor, in February 2020. (Credit: Erin Cassidy Hendrick)

*Celebrate departmental accomplishments across multiple media formats*

Raising the profile of departmental accomplishments makes members of the department feel appreciated while simultaneously advertising these successes within Penn State and beyond. These enhanced multimedia strategies will also support the goals of student and faculty recruitment to showcase the unique research and educational opportunities in our department. Given the additional importance of marketing and communication on departmental rankings, the department will support the communication of department news through a close relationship between the communications strategist and the faculty. Further, training for faculty and graduate students will be available to help them improve communication skills for a wide variety of audiences, enhancing dissemination of departmental accomplishments.





### 3.4 Drive educational innovation to provide Penn State ME students with a high-quality, modern mechanical engineering education

*Support the “can-do” spirit of Penn State ME students through a curriculum that balances theory with practice and continually exposes students to innovative educational opportunities*



*Undergraduate students present during a senior capstone design course in 2019. (Credit: Erin Cassidy Hendrick)*

The students of Penn State’s Department of Mechanical Engineering are “do-ers” – creative problem solvers who can apply the theory learned in class to real-life engineering challenges. To support and propagate this culture for future generations of students, the faculty and staff will ensure students receive a modern and ever-improving education. The curriculum will include the deep theoretical knowledge that builds the foundation, hands-on and computational experiences that help turn theory into practice, and a range of experiences focused on synthesizing these previous experiences to create new knowledge and

engineering solutions. Students will be exposed to cross-disciplinary work in their in-major courses and be given the opportunity to pursue minors that complement their core engineering skills.

### *Charge ME Education Innovation Committee to support the continual development of teaching and learning for faculty and staff*

The ME Education Innovation Committee will lead a number of important initiatives to improve educational offerings. To support educational offerings overall, the Mechanical Engineering Teaching and Learning Initiative (METLI) will facilitate a training and mentoring program for faculty in teaching and advising to support an active culture of improvement. Additionally, the committee will support computing and technology infrastructure for teaching at all levels. On the undergraduate side, the committee will develop course caucus guidelines and empower caucuses to ensure required courses are up to date. Further, these caucuses will ensure that faculty expertise is being utilized and student interests are being met through continual review and development of the technical elective offerings. Finally, the committee should work to identify future trends in education – undergraduate, graduate, and post-graduate – to ensure that our educational offerings are meeting stakeholder needs and position Penn State as a leader in engineering education. This goal will also be supported by enhancing the scholarship of teaching and learning in the department.

### *Develop continual improvement of the graduate programs – resident and online*

The graduate program supports both the teaching and research pillars of the department. To ensure excellence in graduate education, a number of initiatives should be identified to ensure continual improvement of graduate offerings. First, better data collection efforts on graduate education and progress should be instituted in order to continually improve the



graduate program. Further, a two-year review cycle for the online MSME program will be established to ensure its meeting the needs of students and industry. Additionally, a committee will be formed to evaluate the current qualifying exam structure and report to the department on potential necessary changes.

*Provide students meaningful professional, academic, and personal development experiences to encourage lifelong learning*

The department will continue its significant efforts to support the development of undergraduate and graduate students. At both the undergraduate and graduate level, program offerings for professional preparedness will be enhanced, including micro-credentialing, workshops, career counseling, a Ph.D. internship program, and others. Additional efforts on the graduate level will be required to address issues surrounding graduate student retention and community. The department will develop a new on-boarding program for graduate students, both online and resident, and re-imagine continuing education for the graduate population. Finally, the department should continue to engage their alumni and industry partners through post-graduate educational opportunities like micro-credentialing to support life-long learning. These post-graduate programs should also coordinate with the resident educational programs to support the PSMES mentoring program, career counseling, and student awards and scholarships.



Monty Alger, professor of chemical engineering, presents a micro-credentialing seminar on "Business Principles for Engineers" in February 2019. (Credit: Erin Cassidy Hendrick)

*Reinforce the importance of service to the profession*

Participation in professional societies, such as the American Society of Mechanical Engineers, provides students and practicing engineers with important opportunities, including networking, mentoring, and leadership experience. The department should reinforce the importance to service to the profession through participation in professional societies to undergraduate and graduate students through messaging in the classroom, in extracurriculars, and through the faculty's own participation in these societies. Participation of Penn State students and graduates in professional societies enhances the department brand and shows our leadership in our technical communities. Further, continually emphasizing Penn State's role as a land-grant institution in service and outreach activities will be important to fulfilling the university's responsibility to the Commonwealth.



### 3.5 Empower faculty, staff, and students to be leaders at Penn State and beyond

#### *Support faculty taking leadership positions outside the university*

While ME faculty already hold a number of important leadership positions outside the university in professional societies and government committees, the department will further support the tenure- and non-tenure-line faculty in their roles as engineering leaders.

#### *Provide paths for staff advancement*

To support the critical role that staff play in the operation and success of the ME department, pathways for staff support and advancement should be implemented to recruit and retain talented staff members.

#### *Charge Staff Advisory Committee with identifying critical issues for staff*

The current staff committee should be transformed into a staff advisory committee that identifies areas critical to staff needs and liaises with the executive committee, through the Business and Operations Director, in order to identify ways of addressing these issues in a timely and constructive manner.

#### *Encourage faculty to actively participate in university-level institutes*

To raise the profile of ME research within the university and enhance faculty access to the resources available through the university-level institutes (IEE, MRI, ICDS, etc.), the department will encourage faculty to affiliate with institutes closely related to their disciplines and actively participate in institute offerings. The department will also seek opportunities for co-hiring with institutes to enhance faculty recruiting and retention.

### 3.6 Optimize processes, practices, and structures that achieve long-term sustainability, balance due process with agility, and promote accountability to our stakeholders

#### *Optimize and re-imagine staff positions continuously*

To ensure efficient and effective department function, staff positions should be continuously optimized and re-imagined. Given the changing needs of the department, each staff position should be designed in order to most effectively support the office or functional unit in which the staff position resides. Staff in these positions will receive the requisite training in order to enhance the position and its impact on the department. Ensure that staffing levels grow appropriately with the growth in the department.

#### *Develop a ME space plan and work with the College of Engineering to identify future space needs*

Given recent and continued growth of the department and the ongoing development of development plans for the College of Engineering, ME will develop a departmental space plan and work with the College to ensure that current and future space needs are met. The space plan will take into account factors like future hiring directions, supergroup development, staffing needs, graduate student spaces, and the need for complying with export-controlled computing and laboratory restrictions.



*Develop a ME financial plan to ensure excellence in fiscal stewardship*

To properly support the operational needs and future improvements for the department, a financial plan should be developed, communicated to the faculty, and continually updated, in collaboration with the College of Engineering, to ensure our department has the fiscal stability and long-term financial resources to achieve these strategic objectives and support our mission of research, education, and service.

*Review and revise teaching-load policy*

A committee will be formed to review and, if necessary, revise the department teaching load policy. The policy should include not only directives for resident courses, but also retain the current financial incentives for graduate online teaching and advising to ensure the robustness of the online MSME program.

*Evaluate and improve the promotion and tenure process to accommodate increased volume of cases for both faculty and staff workload*

Given the recent growth in the department and the plan for continued hiring in the next five years, the workload on the faculty and staff associated with the promotion and tenure process is high. A committee will be assembled to evaluate the current promotion and tenure process to identify ways in which both faculty and staff workload can be optimized and yet still provide faculty seeking tenure and promotion with the highest-quality support.

*Evaluate and improve the faculty hiring process*

Given the continued growth plans for the department, a committee will be assembled to evaluate the faculty hiring process. Committee members should include faculty and staff who served on faculty search committees in the past several years.

*Develop procedures and contingency plans to ensure continued excellence in the department mission in cases of significant disruption to department operations*

In cases of significant disruption to university or department operations, the department should have in place a set of contingency plans that allow agility and continuity in the face of external challenges. Coordination between the faculty and staff should ensure that the teaching and research missions can continue, in some form, in the face of disruption, and that department assets are maintained. Contingency plans should also include support for online infrastructure and training for all members of the department to ensure operations continue during a disruption. These contingency plans should ensure that both the mission and vision of the department be supported to the greatest extent possible in the face of hardship.

3.7 *Develop and maintain a supportive culture for continuous improvement that responds to emerging needs*

*Institute two- and four-year reviews of the strategic plan to gauge progress and maintain strategic directions*

To remain agile and competitive, the department must assess the strategic plan, including both the strategic objectives and implementation plan, in order to ensure continued improvement over the duration of the plan. To achieve this, a committee will be formed to review



the department's progress on the strategic plan in Year 2 and Year 4 of the plan. This committee will work with the executive committee as well as other pertinent committees within the department to ensure the continued relevance and excellence of the department's strategic plan.

*Implement mid-career faculty development program*

To better support the increasingly large number of recently post-tenure faculty in the department, the ME department should launch a mid-career faculty development program to support the growth of these individuals on their path to full professorship.

#### 4 Implementation plan

The 2019/2020 Strategic Planning Committee recommends the following implementation plan to achieve the long-term strategic objectives described above. This implementation plan is not necessarily exhaustive, and we charge each responsible committee to revise and update the enabling actions and metrics as they see fit over the course of the five-year plan duration. In order to ensure completion of many of these actions, however, the committee recommends that the responsible committee or individual work with the executive committee to identify a budget that could be assigned to certain actions, ensuring that financial resources are available and used.

The following prioritization was determined through a faculty and staff workshop on August 19, 2020 (via Zoom), where breakout groups consisting of both faculty and staff ranked the sub-goals as they stood at that date. Several changes to the plan have been made as a result of the feedback provided at that workshop and so those sub-goals have been inserted into the prioritization based on similarity to other sub-goals that existed in the plan at the time of review and noted with a number and letter (e.g., "2a"). A synopsis of the comments from each team is provided with the rankings to provide context for the ranking. Not all groups ranked all sub-goals, and the rankings are the result of averaging the groups' prioritization scale of 1 – highest priority to 3 – lowest priority.

Rank (includes ties)	Sub-goal and comments
1	<i>Continue to improve the graduate student recruiting process to create a vibrant and diverse graduate community</i>
1	<i>Grow the population of high-quality, under-represented groups in the undergraduate, graduate, staff, and faculty populations</i>
2a	<i>Identify departmental Equity Ambassadors to facilitate diversity and inclusion on committees</i>
3	<i>Optimize and re-imagine staff positions continuously</i>
4	<i>Foster a collegial atmosphere in the department</i>
4	<i>Support the "can-do" spirit of Penn State ME students through a curriculum that balances theory with practice and continually exposes students to innovative educational opportunities</i>
4	<i>Provide paths for staff advancement</i>
4a	<i>Charge Staff Advisory Committee with identifying critical issues for staff</i>
4	<i>Develop a ME space plan and work with the College of Engineering to identify future space needs</i>
4b	<i>Develop a ME financial plan to ensure excellence in fiscal stewardship</i>
4	<i>Evaluate and improve the promotion and tenure process to accommodate increased volume of cases for both faculty and staff workload</i>
9	<i>Implement mid-career faculty development program</i>





9	<i>Support research “supergroups” to encourage collaboration, cross-disciplinary research, and graduate student community-building</i>
9a	<i>Enhance the scholarship of teaching and learning within the department</i>
11	<i>Celebrate departmental accomplishments across multiple media formats</i>
11	<i>Focus on faculty hiring in strategic areas</i>
13	<i>Support formation of research centers and other leadership opportunities for faculty</i>
14	<i>Review and revise teaching-load policy</i>
15	<i>Charge the Research Advancement Committee with promoting the continuous development of faculty research programs and their impact</i>
16	<i>Support faculty taking leadership positions outside the university</i>
16	<i>Provide students meaningful professional, academic, and personal development experiences to encourage lifelong learning</i>
18	<i>Develop procedures and contingency plans to ensure continued excellence in the department mission in cases of significant disruption to department operations</i>
19	<i>Institute two- and four-year reviews of the strategic plan to gauge progress and maintain strategic directions</i>
20	<i>Charge ME Education Innovation Committee to support the continual development of teaching and learning for faculty and staff</i>
20a	<i>Develop continual improvement of the graduate programs – resident and online</i>
21	<i>Evaluate and improve the faculty hiring process</i>
22	<i>Encourage faculty to actively participate in university-level institutes</i>
23	<i>Reinforce the importance of service to the profession</i>