OUR VISION

Our mission for the Department of Civil and Environmental Engineering at the University of Maryland (CEE@UMD) is clear:

“To educate, create knowledge, and engage communities so that society can thrive within the changing built and natural world.”

To achieve this mission, CEE@UMD will organize around four themes:

1. INNOVATE THE CURRICULUM
   Build an innovative and integrated curriculum to reflect the evolution of civil and environmental engineering, attract and retain the best students, meet the needs of a diverse student body, develop the technical workforce needed by industry, educate future leaders, and serve as a model for the profession.

2. EXPAND THE PROGRAM
   Significantly increase the diversity, size, and quality of our program to satisfy demand from industry and to align with our peers.

3. LEAD IN RESEARCH
   Be a nationally prominent powerhouse in areas of critical importance to contemporary society: transportation, environmental, and resilience engineering.

4. SEARCH FOR OPPORTUNITIES
   Incubate new research topics ranging from traditional smart construction and intelligent infrastructure innovations to more forward-looking evaluation of climate change impacts on civil infrastructure resilience and the interactions between human mobility and public health.

Achieving this vision will place us among our peers as a top-10 ranking public program and enable us to fulfill our mission as the flagship land-grant university program in the State of Maryland.
The Department of Civil and Environmental Engineering at the University of Maryland (CEE@UMD) is currently partitioned into six technical groups: structural, geotechnical, environmental, water resources, transportation, and project management. Each tenure/tenure-track (TTK) faculty member is associated with a technical group.

Five professional track (PTK) faculty contribute to the instructional program, and adjunct faculty provide additional teaching support. The graduate curriculum and programmatic requirements are aligned with these technical groups. The faculty in each group determine coursework requirements in their respective disciplines. Undergraduate students choose among three technical tracks: structures and geotechnical, environmental and water resources, and transportation and project management.

**THE DEPARTMENT HOUSES FIVE INDEPENDENT RESEARCH CENTERS:**

- The Maryland Transportation Institute (MTI)
- The Center for Advanced Transportation Technology (CATT)
- The Center for Disaster Resilience (CDR)
- The Maryland Water Resources Research Center
- The Bridge Engineering Software and Testing (BEST) Center

The TTK faculty are divided by rank and technical group according to the following matrix:

<table>
<thead>
<tr>
<th></th>
<th>ASSOCIATE PROFESSORS</th>
<th>ASSOCIATE PROFESSORS</th>
<th>PROFESSORS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRUCTURES</td>
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<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>GEOTECHNICAL</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>ENVIRONMENTAL</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>WATER RESOURCES</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>TRANSPORTATION</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>PROJECT MGMT.</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>3</strong></td>
<td><strong>7</strong></td>
<td><strong>18</strong></td>
<td><strong>28</strong></td>
</tr>
</tbody>
</table>

Table 1: Distribution of TTK faculty across rank and technical group

The distribution of faculty rank is skewed toward the senior rank, with about a third of the department within ten years of retirement. The department should strategically hire new diverse faculty, trained in emerging research areas, to expand our footprint in areas of strategic importance and to incubate new research thrusts.
Undergraduate enrollment in our department averaged 430 for the first half of this decade. However, enrollments have been declining and are now about 15% below that prior average. National trends for civil and environmental engineering (CEE) undergraduates mirror those at the University of Maryland (UMD), even while total engineering enrollment nationally has increased by 50% over the same time. Enrollments in our Masters and doctoral programs have also declined. More recently, it is also due to heightened hurdles for international applicants.

**MULTIPLE REASONS HAVE BEEN SUGGESTED FOR UNDERGRADUATE CIVIL ENGINEERING ENROLLMENT STAGNATION, BOTH NATIONALLY, AND AT UMD:**

- Stale curricula too focused on past practice and neglectful of exciting present and future developments in the field.
- Crowded curricula hamstrung by accreditation requirements that do not enable students to pursue knowledge in their broader interests.
- Programs that lack appeal to today’s students—little or no experiential learning, societal engagement, research opportunities, or “doing good.”
- Outmoded class delivery that ignores changing student learning modes and current engineering education research.
- Inadequate outreach, marketing, and recruitment efforts at all levels—high school, incoming freshmen, transfer students, and nontraditional students.

To put our strategic vision in context, it is important to understand the landscape of CEE programs at public universities. We have identified five aspirational peer public institutions: Virginia Tech, Penn State, North Carolina State, Michigan, and University of California Davis. This selection offers a blend of regional competitors, flagship state schools, and Big 10 and California schools. Each peer ranks above CEE@UMD in the U.S. News rankings of CEE programs. All but Michigan have larger undergraduate enrollments and all have more TTK faculty than CEE@UMD. Enrollment and faculty size are important because they correlate strongly with research volume, reputation, and other measures of educational and research effectiveness.

We exceed our peers in M.S. enrollment and are comparable for Ph.D. production. Rankings data suggest that larger research programs correlate with higher rankings. Therefore, while not of the same urgency as the undergraduate program, it is also important to grow the size of our graduate population.

CEE@UMD significantly outperforms its peers in annual research volume. While the details of research funding make it challenging to directly compare across our peers, our strong current research volume undeniably provides a solid platform for strategically expanding our research capabilities and resources through targeted and diversified faculty hiring.
KEY TRENDS

ORGANIZATION

Historically, CEE departments partitioned themselves into disciplinary silos. This made for a convenient and common nomenclature with which to refer to specialties, graduate concentrations, faculty research interests, etc. Competitive national research funding was historically aligned with these silos. Internally, this structure was convenient for tasks like curriculum assignments and graduate student recruiting.

The contemporary CEE landscape, on the other hand, demands a different model. Projects are much more inter- and intra-disciplinary. Competitive research funding increasingly requires interdisciplinary teams. Solutions require the blending of multiple engineering, scientific, and non-scientific disciplines. Organizing faculty, students, and curriculum into traditional CEE silos does not address current reality, and CEE departments across the country are starting to come to grips with this. Some departments have changed their structure and name to reflect a cross-cutting emphasis on civil systems. Undergraduates want flexibility and opportunities to design unique degree programs. Graduate students are working on more diverse research topics. This does not imply that the silos have simply changed to a different set of silos; rather, that this vertical structure is no longer conducive to effectively attract the best students and faculty.

SERVICE AND EXPERIENTIAL LEARNING

Today’s students are more attuned to global and societal issues than before. Beginning in primary school, they learn about other cultures, diversity, social interactions, and opportunities to participate as global citizens. CEE touches many of the world’s problems in important ways. Our appeal as a department would be increased by providing opportunities to blend traditional curriculum with critical service and experiential learning. Many students want to be in the field or laboratory working with real systems. In addition to gaining deeper understanding, they consider this to be an important practical expertise that appeals to employers and graduate programs.

NEW TOOLS: DATA ANALYTICS

Emerging sensing, geospatial, and internet technologies are producing data in prodigious quantities. Data Analytics comprise the quantitative and qualitative approaches for deriving insights from these data. Examples include machine learning and artificial intelligence.

CEE is an increasingly data-rich profession. Civil and environmental engineers of the future will need to know how to process large sets of data to extract the underlying patterns that can be used to improve the design, safety, performance, and durability of civil infrastructure.
We must address two key enhancements to our infrastructure to better align the CEE@UMD program with trends in civil and environmental engineering:

1. A more fluid and nimble organization; and
2. New facilities to support expanding research activity.

**ORGANIZATION**

To reflect the rapidly changing CEE domain, the department will transform its organizational structure. We will replace the current silos with a thematic approach. Given our current and continuing strengths in transportation, environment and health, and resilience, as well as emerging trends in smart infrastructure and construction systems, we plan to organize around three problem domains (Figure 1):

- Intelligent infrastructure
- Transportation and mobility
- Environment and health

A common overlay will be resilience and sustainability; this shift is required to address societal problems that span multiple domains. Similarly, we have identified a set of tools required to succeed in the three chosen domains.

- Engineering mechanics
- Chemistry and biology
- Data analytics & operations research
- Risk analysis

Figure 1: **PROBLEM DOMAINS**

![Diagram showing the overlap of intelligent infrastructure, transportation & mobility, resilience & sustainability, and environment & health domains, with tool areas including mechanics, chemistry & biology, data analytics, operations research, systems analysis, risk analysis, and project management.](image-url)
One of the most important features of the new structure is that it no longer partitions the department. Individual faculty and students are not required to align with a single category. Rather, they can subscribe to the set of domains that best suit their interests. This organizational model will create the flexibility that students seek and that current and future CEE faculty need. It is a better fit for the nature of modern CEE problems and research themes.

This revised structure does not exclude any existing members of the department. All faculty and students should feel comfortable occupying at least one of the primary problem domains, and most will find themselves at home in more than one. This leaves open the possibility that faculty can evolve their subscribed areas over time as their research interests demand.

This proposed reorganization is not without challenges. The traditional structure made various administrative tasks easier to allocate. In the new structure, for example, prospective graduate students will need a richer vocabulary with which to express their interest areas, and review of their applications will require a more nuanced approach. Similarly, coursework (at any level) can no longer simply be segmented across technical groups and then handled independently; a more holistic approach to course design, scheduling, and advising will be required. Many other areas of department operation will be similarly affected: assignment of faculty to working committees, administration of graduate qualifying exams, and the composition of graduate degree committees, to name but a few. Effort will be required by committees within the department to adapt policies and procedures to this new model and to ensure a smooth transition from the current paradigm to the new structure.

FACILITIES

The CEE department is slated to be the primary occupant of the new Interdisciplinary Engineering Building (IEB), intended for occupancy by 2026. This building will provide badly needed advanced environmental wet/analytical laboratories.

In addition, new research and teaching spaces are planned to support virtual design and building information modeling (BIM); big data visualization, including virtual/augmented reality studios; connected/autonomous vehicle-highway systems; smart construction; and undergraduate capstone and special project needs.

None of these currently exists; this represents an enhancement to the research and educational infrastructure of the department that will enable us to develop a showcase to recruit students and faculty as well as catalyze research opportunities.
Our strategic vision for the future of CEE@UMD is organized around four themes:

1. **INNOVATE THE CURRICULUM**
   Build an innovative and integrated curriculum to reflect the evolution of civil and environmental engineering, attract and retain the best students, meet the needs of a diverse student body, develop the technical workforce needed by industry, educate future leaders, and serve as a model for the profession.

2. **EXPAND THE PROGRAM**
   Significantly increase the diversity, size, and quality of our program to satisfy demand from industry and to align with our peers.

3. **LEAD IN RESEARCH**
   Be a nationally prominent powerhouse in areas of critical importance to contemporary society: transportation, environmental, and resilience engineering.

4. **SEARCH FOR OPPORTUNITIES**
   Incubate new research topics ranging from traditional smart construction and intelligent infrastructure innovations to more forward-looking evaluation of climate change impacts on civil infrastructure resilience and the interactions between human mobility and public health.

**INNOVATE THE CURRICULUM**

Our goal is to build a curriculum that can evolve with the CEE industry, attract talented and diverse students, and serve as a model for the profession. This new curriculum must focus on skills needed not just for the CEE of today but for the needs of the future.

We must abandon the historical approach of satisfying accreditation requirements by adding narrowly specialized courses to the curriculum. Instead our curriculum can focus on longitudinally organized subject material, project-based learning, and teamwork within a framework of modern pedagogical approaches. It must also emphasize the broader issues surrounding CEE—e.g., public policy implications, social equity issues, and climate change impacts.

Training in and application of professional communication skills must be emphasized. We must consider new curriculum options to match department strengths and student interests. Possibilities include: a separately accredited environmental engineering degree; an engineering management program; emphasis on sustainability and resilience; a data analytics track; and perhaps even a non-accredited track.

We should leverage our National Capital—Baltimore location for organized experiential programs like internships, co-op programs, and service learning. A mandatory community service experience will teach students what it means to be part of a “people-serving profession”. An innovative curriculum would allow students to enroll in classes that take them outside of the classroom and away from the usual paradigm of problem sets and exams.
A NEW CEE@UMD
AMBITIOUS VISION

INNOVATE THE CURRICULUM (cont.)

In today’s world, students must be able to demonstrate competency by doing, building, and making, working in teams, and developing relationships with community partners. Options include on- and near-campus partners where students can meaningfully contribute to their campus and nearby communities while increasing the sense of fellowship between the university and its neighbors. Another option is leveraging programs like Engineers Without Borders or Study Abroad to form long-term international partnerships.

How will we know if we are successful in innovating our curriculum? The best evidence will be increased interest in CEE from students and larger and more diverse enrollments in our programs. Evidence of other CEE departments emulating our model will be powerful confirmation. Other more concrete documentation will come from the success of our graduates as evidenced by placements in industry and top graduate programs, attaining leadership roles in industry and the profession, and entrepreneurship.

The Board of Visitors and our Corporate Partners can also provide vital real-world feedback. Ideally, we will also see our curriculum innovations generate scholarly pedagogical output—e.g., dissemination at engineering education forums, such as the annual American Society for Engineering Education conference—and broader media recognition.

EXPAND THE PROGRAM

Industry need for civil and environmental engineers exceeds our supply and the trends are worsening. CEE@UMD is significantly smaller than our peers, which constrains the size of our graduating student cohorts and our ability to compete with the top CEE programs.

Our goal is to significantly grow the size of our program to match those of our peers and to meet industry needs. We want to enhance our undergraduate programs and increase enrollments and Bachelor of Science (BS) degree production by 30% over the next decade while maintaining the high quality of the students attracted to the program.

It is troubling that more entering engineering students do not declare CEE as a major from the start. New facilities and more hands-on learning activities within a modernized curriculum, aggressively marketed via early outreach, campus tours, and contemporary communication channels, will promote the CEE department and major. These efforts will be coupled with an effort in recruiting by our current students. The department will reach out to high school science, technology, engineering, and math (STEM) educators and guidance counselors to give them a clear understanding of what the modern CEE profession entails and how CEE@UMD offers an exciting opportunity to learn the discipline.

We propose to enhance graduate enrollments and degree production by increasing our research activity and by extending our innovations in M. Eng. degree and certificate education, emphasizing that advanced degrees are increasingly the entry level degree in many CEE sub-disciplines.
A NEW CEE@UMD
AMBITIOUS VISION

Our faculty size must grow by 30% to maintain student-faculty ratios and better match our peers. We can achieve these increases by aggressively promoting and improving student, faculty, and staff diversity pervasively throughout the department. TTK hires will be aligned with our research focus areas. PTK faculty must be strategically hired to fill department needs where their special skills make them the best option.

How do we expand our program? The first and most important step is to innovate the curriculum to increase its appeal to a broader and more diverse range of today’s students. We must retain technical depth but add flexibility and “air.” We must include new topics like public policy, climate change, social equity, and diversity that resonate with today’s students and which will prepare them to be nimbler and successful in the future.

Second, we must develop marketing, outreach, and recruitment programs. All target audiences will be pursued: high school (Maryland and out-of-state), community colleges, other University System of Maryland (USM) campuses, internal transfers within the Clark School, and undesignated applicants in Letters and Sciences. Nontraditional prospective students represent an opportunity. Effective outreach and recruitment will require digital, multimedia, and other marketing materials that speak effectively to today’s prospects.

LEAD IN RESEARCH

Our goal is for CEE@UMD to become a nationally prominent powerhouse in key research areas critical to contemporary society: transportation, environmental, and resilience engineering. We will build on existing strengths in these areas and better market our prowess.

Several concrete steps are necessary for us to achieve our goal. The first is the reorganization of the department. A thorough update to our Department Plan of Organization is currently underway. Our programs and faculty must be realigned to match our key focus areas. We plan to grow our faculty size by 30% with research hires aligned with targeted research focus areas. We must leverage our unique location advantage by integrating our research and education activities into the local and regional community service and public policy realms. We must “creativize” our communications efforts to send our message to the broader public more effectively.

SEARCH FOR OPPORTUNITIES

Although we must build on our strengths, we must also remain sufficiently nimble to pursue exciting new opportunities. We will identify and incubate emerging research topics that have the potential to transform research and practice in CEE and grow into department pillars.

We already have a foothold in some possible domains—e.g. smart construction and intelligent infrastructure. Furthermore, we must remain ready to participate in college- and university-wide initiatives.
SUCCESS
THE NEXT STEPS

The coming decade will be an exciting time for CEE@UMD. Our vision is ambitious, but achievable. Our departmental reorganization will better align the department with the complex and multidisciplinary nature of the field today and the future. The new IEB will give the department a rare opportunity for adding state-of-the-art research labs, teaching facilities, and assembly spaces. Following through with the strategies outlined in this strategic document, the department will be positioned to become one of the preeminent CEE departments in the country.

An implementation plan will be developed to bring our vision to fruition. This plan will detail concrete steps, deadlines, and metrics. Some critical components of this plan are already clear:

1. **INNOVATE THE CURRICULUM** as a model for 21st century engineering education:
   - Build on the best ideas we can find and empower a Curriculum Committee with diverse and unbiased perspectives to develop a radically new curriculum incorporating technical rigor, project-based learning, longitudinal integration, professional communication skills, and experiential service learning.
   - Provide the resources and staff to implement, manage, monitor, and document the new curriculum. These may include an Associate Chair for undergraduate programs, additional academic advisors, Graduate Teaching Assistants, and Undergraduate Teaching Fellows.
   - Invest in advancing technical and professional communications skills in our graduates. Options may include a communication coaching staff and industry advisors.

2. **EXPAND THE DEPARTMENT** to increase undergraduate enrollments and faculty size by 30% by the end of the decade:
   - Launch and sustain creative recruiting and marketing campaigns targeted at high school, community college, other USM, and UMD students for the undergraduate program.
   - Enhance student support services.
   - Solidify institutional and external support for increased faculty hiring.

3. **LEAD IN RESEARCH** to achieve 30% growth in research productivity and Top 10 prominence by the end of the decade:
   - Focus faculty growth in targeted critical research areas.
   - Develop funding pools for faculty start-up packages and other hiring incentives to attract the best candidates and allow them to thrive in our program.
   - Promote and expand the B.S./M.S. dual degree program.
   - Support funded undergraduate research experiences.
SUCCESS
THE NEXT STEPS

4. SEARCH FOR OPPORTUNITIES

“It’s tough to make predictions, especially about the future.”

- Provide flexible and well-equipped research labs that are conducive to exploratory research.
- Assist individual investigators to broaden the scope of their research innovations by fostering research partnerships.
- Provide seed funding for promising new research and education initiatives.
- Support individual faculty development into new areas of expertise.

Some of these components will be difficult; all will take time. The construction schedule for the IEB will dictate the schedule for some elements of the implementation plan. But it is important that we begin.

The start of a new era for CEE@UMD is NOW.
ENDNOTES

1 Undergraduate enrollments for peers are 30% larger than CEE@UMD on average.

2 TTK faculty size for peers is 50% larger than CEE@UMD on average.

3 CEE@UMD M.S. enrollment is 35% larger than the average of our peers.

4 CEE@UMD annual research expenditures are 115% larger than the average of our peers.

5 Yogi Berra
ABOUT CEE@UMD

For more than a century, the Department of Civil and Environmental Engineering at the University of Maryland (CEE@UMD) has fostered excellence in undergraduate and graduate education while advancing research that improves lives globally and safeguards the environment.

CEE.UMD.EDU