Department of Computational Mathematics, Science and Engineering

Strategic Plan Summary 2025

The Department of Computational Mathematics, Science and Engineering (CMSE) is transforming research and education at Michigan State University. Jointly administered by the College of Natural Science and the College of Engineering, CMSE focuses on the synergy among algorithms, computing, and physical, biological, and engineering applications. The department provides an interdisciplinary environment for scientists, engineers and mathematicians to address emergent, high-impact problems in their fields using computational methods. This document presents our plan for a continued commitment to excellence in areas of teaching and research, in line with the goals of Michigan State University as a land grant institution.

"CMSE will be an interdisciplinary unit that strives to focus on algorithmic science and its applications to a range of critical research topics."

As the department neared its 5th year we started discussing, organizing, and planning for the next 5 years. The Long Term Planning Committee (LTPC) was formed on May 1st, 2019 and consists of a diverse representation of thirteen faculty, staff, postdocs and graduate students. Given the two primary missions of the department, Education and Research, and input from members of the department, the LTPC has identified 4 topical areas for the focus of this strategic plan:

1. Improving department culture and integration
2. Continued leadership in education: practice and impact
3. Increasing departmental diversity
4. Research collaboration, directions, productivity, and impact

The following sections describe each of these areas in detail with specific recommendations and metrics identified to evaluate the progress toward our goals.

Improving department culture and integration

We have identified internal communication (or lack thereof) as the number one priority to improving culture and integration within the department. To this end, ***it is recommended that the department appoints a Director of Communication to chair a Communication Committee (CC)***. The CC will consist of representatives from departmental groups (faculty, staff, postdocs and students) and it will be their committee's responsibility to help foster departmental culture and integration goals. The hope is that the CC will implement policies that encourage departmental communication and interactions. These policies may include a weekly departmental newsletter, faculty lighting talks, brown bags, a yearly departmental retreat, department-wide social events, etc. The CC will measure the impact on internal communication in an annual review by surveying and interviewing representatives from the entire CMSE community. This report will be presented to the faculty in December of each year and will include plans for the upcoming year.

We also have identified a heavy service committee burden and committees with vague objectives as stalling improvement in multiple areas. The department may reevaluate all current standing committees and dissolve, merge, diversify, or update scope. Similarly, with more degree programs associated with CMSE and increased enrollment, the Department may need to consider means to alleviate faculty teaching load, particularly among pre-tenure faculty. Considering most of our faculty have dual appointments with unusual demands from different units, means to alleviate service and teaching load is expected to directly and positively impact our departmental culture and integration.

Continued leadership in education: practice and impact

As a department, we provide education to diverse groups of students (both in the department and as service to other departments) and strive to target both foundational training and cutting-edge topics. The LTPC identified four major areas of focus for education in the next five years:

1. Addressing concerns about the core graduate courses (CMSE 820 Mathematical Foundations for Data Science, CMSE 821 Numerical Methods for Differential Equations, CMSE 822 Parallel Computing, and CMSE 823 Numerical Linear Algebra).
2. Continued support for services courses for non-majors (CMSE 801/802, Undergraduate and graduate Minors and the Bioinformatics Program).
3. Solidification and growth of the undergraduate Data Science Major.
4. Research into best practices for online education in light of the COVID19 pandemic and the general trend toward online education.

Areas of Improvement for Core Courses: Currently, the finals for the core courses also serve as subject exams for CMSE graduate students, which has led to uneven testing experiences. There has been discussion about generating question banks for standardized tests for the future. Recent evidence also shows that when some of these courses have been taught by faculty in other departments, there have been significant differences in the balance between theory and practice. These concerns have led to discussion about standardizing the curriculum for each of these courses, which would also provide opportunities to update the curriculum over time. ***These and other concerns are being considered by the CMSE Graduate Studies Committee with plans for improvements to be implemented in 2021.***

Service Courses for Non-Majors: Enrollment numbers for the department's core service courses (CMSE801/802) and the undergraduate minors for the AY2019-2020 have been near capacity. The department plans to continue and even increase support for these courses due to their popularity. With the increased enrollment, the department needs to consider approaches to fulfill the teaching needs without further increasing the teaching load for faculty and staff. The Bioinformatics Program (led by Dr. Alexis Black) started with a series of modular courses and two graduate courses and has serviced over 250 students/auditors in three years. The modules are non-traditional courses that are one-month, flipped classes covering topics ranging from introductory programming in various languages, statistics, Linux on the HPCC, basic genome sequencing data analysis, and a few more advanced genomics research applications. ***The next step is for Dr. Black to work with the Bioinformatics Committee to draft and submit a proposal for a Bioinformatics Graduate Certificate with a goal of having this certification approved by 2022.***

Data Science Degree: In Fall 2019 the new Undergraduate Major in Data Science went live and currently there are over 50 students declared majors with enrollment growing fast. Courses are offered in conjunction with Statistics, and Computer Science. Organization of these programs are being led by Dr. Devin Silvia and Dr. Adam Alessio. With the immediate interest from students, ***there is a need for an advising specialist to help students transfer credits, be placed in appropriate classes, provide professional development information, and career advice***. Furthermore, the new Data Science Major requires the creation of four new courses (CMSE 380, 381, 382, and 495 starting one per semester in Fall 2020-Spring 2022). Substantial effort needs to be given to starting and ensuring that these courses are strong and in keeping with the degree-wide learning objectives. Given the popularity of the Major, these courses will need to scale to serve large class sizes. **There will be a specific need to identify a course lead for CMSE 495 in order to facilitate industrial connections early to offer students a rewarding experiential learning opportunity starting Spring 2022.** The

Undergraduate Data Science Curriculum committee will help oversee these course development efforts. The Graduate Studies Committee is also laying the groundwork for an online Data Science Master's Degree.

Online Education Committee: In response to the COVID-19 pandemic in March 2020, an Online Education Committee was formed to support faculty in rapidly transitioning to online courses. The committee has been investigating best practices, evaluating software/hardware, and providing one-on-one consultation. For the future, the Online Education Committee will merge with the Learning Technology Committee to investigate solutions for low-bandwidth education and academic assessment. It will also evaluate online department courses and suggest improvements for minimizing bandwidth/technology requirements for students, for effective and accessible content delivery, and for updating cybersecurity. The goal is to regularly offer at least one online section per service course and potentially for core courses even after the pandemic is over.

Increasing departmental diversity

As a department, we value diversity and recognize the importance of increasing the representation of faculty, staff, postdocs and students within our unit from different backgrounds and social identities, including, but not limited to, race, ethnicity, sex, gender, religion, sexual orientation, socioeconomic status, age, ability status, and national origin. We acknowledge that the current composition of the department does not reflect these goals and continue to seek a team composed of people from diverse backgrounds that will lead to greater diversity in thought, perspective, and viewpoints, which leads to higher productivity and more creative solutions.

When approaching issues related to diversity, equity, and inclusion, it is important that our actions are thoughtful and deliberate so that we not only increase our diversity but also promote cultural change that creates an environment where all individuals and perspectives can thrive. In pursuit of this ***we propose to 1) immediately schedule department-wide meetings to discuss recent events regarding diversity, equity, and inclusion (DEI) to open up the conversation and 2) create a DEI committee*** that leverages MSU resources to maximize diversification of CMSE at all levels. All members of the CMSE community will be able to volunteer for the DEI committee and members will be selected from the list to ensure representation of the entire department (ex. faculty, staff, postdocs and students). This committee will be responsible for developing strategies to integrate diversity promoting activity into all of the work of the department, tracking departmental diversity initiatives, and making suggestions to the Chair, Advisory, and Leadership Committee. To this end, we plan to actively seek out diversity with the DEI committee starting the following initiatives in the next two years:

- Be involved in reviewing departmental initiatives (ex. new student orientations, creating course material) to provide support for achieving departmental DEI Goals.
- Help review department-wide emails to help address diversity issues that come up within CMSE classes, in other places in general, or large scale issues arising in society
- Communication and integration efforts for all search committees
- Create named postdoctoral fellowships to encourage diverse candidates
- Focus recruiting efforts at institutions with high levels of diversity
- Provide graduate student scholarships for diversity enhancement, and until such scholarship funds can be attained, reserve a yearly TA position for an incoming student with a diverse background
- Host continuous facilitated discussions and workshops on DEI and unconscious bias
- Seek out diverse speakers for our colloquiums and brown bag workshops
- Actively seek out ways to increase the diversity of CMSE leadership

Research collaboration, directions, productivity, and impact

The long-term goal for CMSE is turning it into a central hub on MSU's campus for computational modeling and data science-related research. Researchers in other departments can seek collaboration with CMSE faculties easily and smoothly, or be directed to related departments with the help of CMSE. To this end, CMSE should seek to

1. Hire researchers who do fundamental research on algorithms development and mathematical analysis to ensure the depth of the collaborative research
2. Hire domain specialists who understand both the theory and the application
3. Create a culture that encourages more interaction/collaboration
4. Communicate with faculty outside CMSE to create a network of professionals in related areas to facilitate collaborations

The plan for achieving these goals is the following:

To achieve goals 1 and 2, the department will; ***1) Hire 3 full-time or 6 half-time tenure-track faculty per year for the next 4 years (2021-2025). 2/3 of the hires are under the College of Engineering and 1/3 are under the College of Natural Science. 2) Hires are expected to be in the directions of Quantum Computing, Big Data and Biology, Modeling in Biological Systems, Computational Materials and Core Algorithms. For the longer term, the Chair should engage the entire Department in discussing strategic direction for the next five years.***

To achieve goal 3, we recommend the ***formation of a Research Cluster Committee*** to expand on the work started by Drs. Murillo, Ravishankar, Dickson and Alessio. This committee will work with the Director of Internal Communication to help facilitate formation of cross-discipline research groups and help break down research silos. This may include, but is not limited to, programs such as shared department presentations, joint brown-bag presentations, fostering new journal clubs, etc. The evaluation of accomplishment of these objectives in five years will be based on the quality and the quantity of (joint) publications, the number of Ph.D. graduations, and the number of funded (joint) proposals with a specific target of center-level grants.

To achieve goal 4, we recommend having the Director of Communication also act as a contact person for faculty outside the department with appropriate websites and appearances at outside department seminars/receptions. This person or others on the Communications Committee can then direct external faculty to CMSE faculty as necessary to support their research goals.

Assessment

An important activity in parallel with all of these goals, is evaluation of the performance. We recommend that all critical activities have a metric to gauge success. In addition, we recommend that annual reports that discuss progress and failures be shared with the department to increase transparency. We would like everyone to be aware of ongoing activities in order to share the responsibility of planning and future success.

Appendix: Full Strategic Plan - Link to Draft of Full Document