Center for Materials Research in Archaeology and Ethnology

The mission of the Center for Materials Research in Archaeology and Ethnology (CMRAE), a consortium of eight Boston-area educational and cultural institutions, is to advance our understanding of prehistoric and nonindustrial societies through analysis of the structure and properties of materials associated with human activity. These materials include plant and animal food remains and skeletal material, as well as metal, ceramic, stone, bone, and fiber artifacts, along with the environments within which these materials were produced and used. The center hosts and manages facilities that support teaching undergraduate and graduate classes in archaeology, along with student research activities.

With important guidance and input from CMRAE faculty, the Department of Materials Science and Engineering (DMSE) established an undergraduate major in archaeology and materials, Course 3-C, as well as an interdisciplinary doctoral degree program in archaeological materials in 1999. These are the only academic degree programs of their kind in the United States. The graduate students enrolled in the PhD program, as well as the undergraduate Course 3-C majors who participate in the Undergraduate Research Opportunities Program (UROP), all carry out their dissertation and senior thesis research in the CMRAE laboratory facilities. This year, CMRAE staff assisted with one senior thesis project and began discussions with other 3-C students to choose projects for their theses in the coming academic year.

This academic year was a transition year for CMRAE. As of September 1, 2022, Professor Allanore is the new director of CMRAE, succeeding Professor Lechtman, Professor Emerita of Archaeology and Ancient Technology. The new director has conducted a series of meetings with the member-institution representatives and interested parties within MIT with the objective of renewing some of the current CMRAE course offerings and fostering engagement within MIT and throughout the greater Boston area.

The center supported several courses offered at MIT that are open to students from the member institutions. The flagship UG course 3.985 Archaeological Science had 99 students, this year being an outlier as students were exclusively from MIT, whereas typically 5 to 10 students from the member institutions enroll every year. Lecturer contributions came from MIT Department of Civil and Environmental Engineering (DCEE), MIT Department of Earth, Atmospheric, and Planetary Sciences (EAPS), MIT Department of Materials Science and Engineering (DMSE), UMass Boston, the Museum of Fine Arts, Harvard, Yale, and Boston University. The students learned about a broad range of topics and materials, ranging from paleogenomics, disease, gut microbes and pigment use to remote sensing for the archaeology of Iceland, including forays into the ceramics of Mesoamerica and the preservation of the Dead Sea Scrolls from the Levant.

During the spring term, 17 undergraduate students (and 1 Harvard University graduate student) in the subject 3.094 Materials in Human Experience engaged in lecture and laboratory sessions that explored modern and historical iron smelting technologies, particularly those in use among the Mossi people in Burkina Faso, and the processing and use of architectural lime mortars and concretes in the ancient Roman empire.

Sustainability issues with iron and concrete production were emphasized in class, focusing on how the human history of these two materials have made them the two biggest global contributors to atmospheric carbon dioxide levels in the present, and how new technologies may evolve to mitigate CO_2 production in the future. The laboratory project assigned for the Roman concrete unit focused on the reproduction of a Roman wall and frescos. Students processed raw materials, then designed and tested suitable concrete mixtures. The students later built a brick wall using their mortars and prepared a lime mortar surface for their fresco. The class reproduced two Roman fresco scenes – one depicting Bacchus and the other a rural scene – using period- and culturally-correct pigments and minerals. In the iron smelting unit, the students built a Mossi-style iron smelting furnace from a clay-straw composite, including a furnace body, tuyeres, nozzles, and goat-skin lined bellows. At the end of the semester, the students carried out an all-day iron smelting experiment in the BBQ pits of East Campus, taking shifts pumping the bellows by hand. The 3.094 students carried out both the iron smelting furnace building and the Roman wall building activities in the DMSE Merton C. Flemings Material Processing Laboratory.

The center also offered 3.984/3.989 Materials in Ancient Societies, a 2-semester long, laboratory intensive graduate class focused on a specific material. This year, students pursued in-depth study of the technologies ancient societies used to produce objects from ceramic materials. The class culminated in the laboratory analysis of archaeological ceramics. One project investigated Chalcolithic coarse ware vessels from a site in Israel, while the other project worked on material from Uzbekistan on loan from the Peabody Museum of Archaeology and Ethnology (Harvard). The students also learned techniques by working on sherds from the Central Depression of Chiapas (Mexico) as part of a larger research study.

Finally, the course 3.098 Ancient Engineering: Ceramic Technologies enrolled 13 registered students and 2 listeners, including a cross-registered student from Harvard and students from multiple MIT departments, including Materials Science and Engineering, Civil Engineering, Electrical Engineering and Computer Science, and Earth, Atmospheric and Planetary Science. The students learned about how ancient people made and used a wide variety of ceramics (from pottery and glass to pigments and cements) in their everyday lives. The class culminated with a capstone project where students did original research into topics as diverse as heat transfer through different shapes of ceramic cooking pots and avian symbology in ancient Chinese porcelain production.

This academic year, as a new activity for the center, guest lecturers were invited to deliver talks on the MIT campus and meet professors, researchers, and students, with the objectives of fostering collaboration, developing interdisciplinary research, and exposing the community to research activities beyond the Boston area. Dr. Danielle Raad (SM ‘15) from Yale University Art Gallery discussed how materials can embody the passage of time and hold memory in their shape, structure, and social lives, through examples ranging from contemporary art, to lacquer-coated wooden objects from ancient Asia, to antique plaster replicas found in US University collections. Dr. Vanessa Workman from the Penn Museum presented archaeological findings related to the early adoption and adaptation of iron production technologies in the Levant. A third guest,

Dr. Brandi MacDonald from University of Missouri was invited, in collaboration with the Department of Materials Science and Engineering, to present insights into mineral pigment use and cave paintings in Stone Age southern Africa and Holocene North America, using advanced materials characterization methods.

This summary of the center's educational efforts in 2022-2023, in undergraduate, graduate, and community-based settings, illustrate a continuation of the 46 years of CMRAE contributions towards MIT's mission statement, to "advance knowledge and educate students in science, technology, and other areas of scholarship." Indeed, CMRAE provides a unique educational service to MIT and the surrounding academic community since 1977, and hopes to continue to do so into the future.

Antoine Allanore
Director