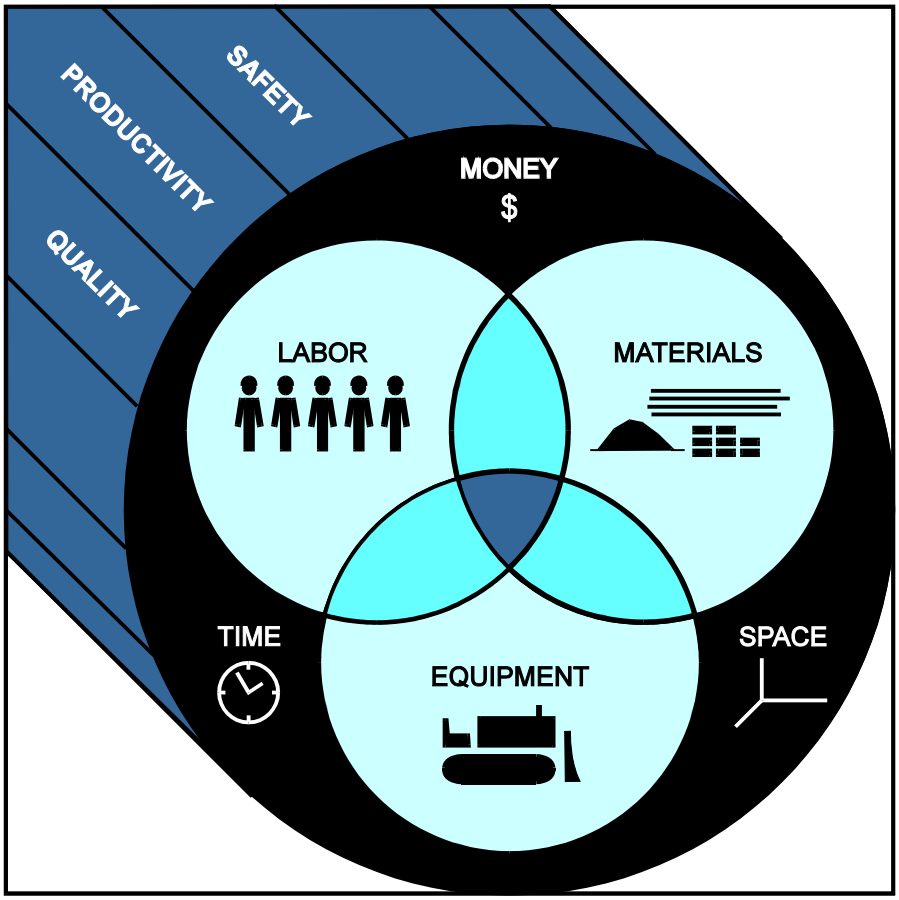
THE UNIVERSITY OF MICHIGAN

GRADUATE STUDIES

Tishman Construction Management Program

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING



The Master of Science in Engineering program in Construction Engineering and Management, established in 1954, pioneered construction graduate education. Graduates lead construction engineering and management organizations throughout the world. The Master of Engineering program in Construction Engineering and Management, established in 1994, continues this tradition with its strong emphasis on the highest level of professional practice. The integration of theory and practice in construction engineering and management attracts practicing engineers as well as recent engineering graduates. The PhD program focuses on the doctoral students' dissertation research. Graduates have made significant contributions to knowledge in construction engineering and management, and occupy academic and research positions at leading institutions worldwide.

The Michigan Engineer is taught to perform at the three functional levels of construction management:

Construction Organization — Form a construction company or department and organize and direct its marketing, financing, estimating, personnel, purchasing, quality assurance, accounting, and control functions.

Construction Project — Estimate, bid, plan, schedule, control and manage a project at a profit, including: contract negotiations, material selection, purchasing, financing, personnel, labor relations, subcontract procurement and coordination, safety, quality assurance, accounting, and schedule and cost control functions.

Construction Operations — Plan and supervise construction operations, select and train crews; select and maintain equipment; select, fabricate, erect, install, and test materials; measure and analyze operations for improved safety and productivity.

THE UNIVERSITY OF MICHIGAN – TISHMAN CONSTRUCTION MANAGEMENT PROGRAM

MASTER'S DEGREE PROGRAMS

The **Master of Engineering (Construction Engineering and Management)**, abbreviated MEng (CE&M), is intended for students concentrating on state of the art construction professional practice. It requires 30-31 hours of coursework that follow the program below.

CEE 531–Construction Cost Engineering	3 hr
CEE 532–Construction Project Engineering	3 hr
CEE 536–Critical Path Methods	3 hr
CEE 530–Construction Professional Practice	3 hr
Graduate civil engineering construction electives	9 hr
Minor concentration electives	6 hr
Program elective	3 or 4 hr
	30 or 31 hr

MEng (CE&M) students select a minor concentration in an appropriate area outside Construction Engineering and Management, such as another area of Civil and Environmental Engineering, another department of the College of Engineering, the Graduate School of Business Administration, or the Graduate Program in Architecture. The MEng (CE&M) program elective may be selected from graduate construction courses or from other areas, including those listed for the MEng minor concentration.

The **Master of Science in Engineering (Construction Engineering and Management)**, abbreviated MSE (CE&M), is intended for students interested in combining research with construction professional practice, including students who wish to pursue a PhD following their Master's study. The MSE (CE&M) requires 30-34 hours of coursework that follow the program below.

CEE 531–Construction Cost Engineering	3 hr
CEE 532–Construction Project Engineering	3 hr
CEE 536–Critical Path Methods	3 hr
CEE 630–Directed Studies in Construction Engineering (with report or thesis)	3 or 6 hr
Graduate civil engineering construction electives	9 hr
Business, Industrial and Operations Engineering, or other management elective	3 hr
Mathematics, probability, statistics, or computer science elective	3 hr
Program elective	3 or 4 hr
	30 - 34 hr

The MSE (CE&M) program elective may be selected from graduate construction courses or from other areas, including those listed above for the MEng minor concentration.

The **Master of Science in Engineering (Civil Engineering)** is for students who want to combine courses in Construction Engineering and Management with courses in other areas of Civil and Environmental Engineering. This degree requires the same coursework as the MSE (CE&M), except that 6 hours of program electives must be outside the construction area.

The academic year consists of the Fall Term (September-December) and the Winter Term (January-April). A limited number of courses are also taught in the Spring Term (May-June).

Most students take a total of 27-28 hours in the Fall and Winter Terms, and 3 hours in the Spring Term, completing the program in ten months of study. A few well-prepared and highly-motivated students complete the program in eight months of study.

All course selections must be approved by the student's academic advisor and the TCMP Program Advisor.

DUAL MASTER'S DEGREE PROGRAMS

The Tishman Construction Management Program has developed formal dual degree programs with the College of Architecture and Urban Planning and the Graduate School of Business Administration through which a student can earn the MEng (CE&M) and the Master of Architecture or the Master of Business Administration. Dual programs have also combined the MEng (CE&M) or MSE (CE&M) with Master's in structures, materials, geotech, industrial and operations engineering, and naval architecture and marine engineering. Students complete course requirements for both degrees; however, dual counting of some courses reduces the total hours below that required when pursuing the degrees separately.

For each dual degree program, prospective students must apply to, meet all admission requirements for, and be accepted independently into both programs. Students enrolled in any of the individual programs may apply for admission to a dual program, but they can save time and unnecessary coursework by planning both programs in advance. These dual programs provide unique opportunities to gain the knowledge and credentials of two related programs, each of which is recognized to be among the strongest in the United States.

Master of Architecture. The dual degree program combines the two-year 60-hour M Arch program with the one-year, 30-hour MEng (CE&M) program, resulting in a two and one-half year, 75-hour program.

Master of Business Administration. The dual degree program requires the 12 hours of core courses and 6 hours of graduate construction electives in the MEng (CE&M) program and the 30 hours of core courses and 15 hours of electives in the MBA program. Students also take a 3-hour independent study course (CEE 630) to integrate general Construction Engineering and Management skills. Students also take Construction Contracting (CEE 431) if they have not taken it or its equivalent previously. The dual degree program combines the two-year, 60-hour MBA program with the one-year, 30-hour MEng (CE&M) program, resulting in a two-year (including Spring and/or Summer terms) 66- or 69-hour program. The dual degree program can be completed in two years if the first year is devoted to core MBA courses.

Master of Science in Engineering. Dual MEng and MSE degree programs combine a 30-hour MEng (CE&M) or MSE (CE&M) program with another 30-hour Master's program resulting in a 51-hour program, 9 hours of which satisfy requirements for both programs. Usually these 9 hours are core courses from the other Master's program, used as electives in the Construction Engineering and Management program. An applicant who has recently received or is working toward a Master's degree in another area of engineering at Michigan can complete the MEng (CE&M) or MSE (CE&M) with an additional 21 hours of coursework.

PhD DEGREE PROGRAM

The Ph.D. program in Civil Engineering (specializing in Construction Engineering and Management) is open to outstanding applicants who have demonstrated excellence in their coursework and a capability for independent research. The focus of the doctoral work is on the student's dissertation research, which must make a significant contribution to knowledge. All admitted Ph.D. students are offered a Fellowship and full financial support for the entire duration of their program.

Ongoing and recent research by TCMP faculty and students has included the following topics:

Dynamic Project Management

The Dynamic Project Management (DPM) group aims at understanding and managing the construction dynamics in large-scale construction projects. Particularly, DPM strives to support diverse decision making processes in order to manage schedule, cost, and quality as well as sustainability and safety using emerging technologies. DPM also has a great interest in how the decisions made can affect people's behavior and ultimately, would like to incorporate it to support the decision making processes. To this end, DPM uses computer simulation (System Dynamics, Discrete Event Simulation, and Agent-based Modeling), automatic data capture and tracking technologies (computer vision, wireless sensor network, RFID equivalent technologies, and emission sensor), and visualization techniques. For more information, please visit http://dpm.engin.umich.edu/ or contact Professor SangHyun Lee at shdpm@umich.edu.

Sustainable and Intelligent Civil Infrastructure Systems

Current research in the Sustainable and Intelligent Civil Infrastructure Systems Laboratory (SICIS) focuses on understanding and modeling the impact of occupants on energy use in buildings, and developing decision frameworks to assist in building operations and management; as well as, sustainable retrofit decisions. The research team uses several tools such as energy simulation, complex adaptive systems modeling, high-level architecture and informatics. For more information, please visit http://sitemaker.umich.edu/menassa/home or contact Professor Carol Menassa at menassa@umich.edu.

Laboratory for Interactive Visualization in Engineering

The Laboratory for Interactive Visualization in Engineering (LIVE) conducts research focused on Automation and Robotics, and its applications in the construction, operation, and maintenance of civil infrastructure systems. LIVE is also conducting research in Real-Time Visualization and its applications in construction process monitoring and control. The LIVE also has significant expertise and experience in visual simulation, virtual and augmented reality, indoor and outdoor positioning systems, mobile computing, and its applications in construction and other engineering domains. The LIVE is equipped with several mobile robotic platforms (iRobot Create; CoroBot; Husky) and other pieces of computing, positioning, and reality-capture hardware. For more information, please visit http://live.engin.umich.edu or contact Professor Vineet Kamat at vkamat@umich.edu.

ADMISSION REQUIREMENTS

Admission to a Graduate Program in Construction Engineering and Management is offered to applicants who provide sufficient evidence that they meet the requirements for study at an advanced level. An entering Master's student will normally hold a Bachelor's degree with a minimum of a B average in the last two years of undergraduate work. Admission to the MEng (CE&M) and MSE (CE&M) programs is open to applicants with a Bachelor's degree in engineering. Admission to the MSE (Civil Engineering) program is open to applicants with a Bachelor's degree in Civil Engineering or its substantial equivalent. The Graduate Record Exam is recommended for admission to the MEng (CE&M) program and required for admission to MSE and PhD programs.

Applicants with Bachelor's degrees in architecture or other non-engineering programs may be admitted to the MEng (CE&M) program if they have taken a year of calculus and a year of physics and if they have a B average in their mathematics and science courses. In addition to their graduate Construction Engineering and Management courses, these students must complete (with a B average) the following courses at Michigan, or their equivalents at another university: Civil Engineering Materials (CEE 351), Structural Engineering (CEE 312), Construction Contracting (CEE 431), and Soil Mechanics (CEE 345).

Structures courses taken in an Architecture program satisfy the CEE 312 requirement. With proper planning, CEE 351, CEE 431, and CEE 345 can be included in University of Michigan B Arch and M Arch programs.

GRADUATE CIVIL ENGINEERING CONSTRUCTION COURSES

CEE 431 is 4 credit hours. All other courses are 3 credit hours. All may be used for graduate credit by graduate students.

CEE 431–Construction Contracting
Construction contracting for contractors, architects, owners. (1) Organization and administration; industry structure; construction contracts; bonds, insurance. (2) Planning, estimating, and control; quantity takeoff and pricing; labor and equipment estimates; estimating excavation and concrete; proposal preparation; scheduling; accounting and control. Students use contract documents to prepare detailed estimate. Prerequisite to CEE 531 and CEE 532. Graduate credit only as program elective.

CEE 501-007– Wind Energy Development, Engineering, and Construction
Wind analysis, wind farm siting, wind turbines, energy production. Civil, geotechnical, foundation, structural, electrical, fiber optic design. Construction, sitework, turbine erection, bolting, cranes, safety, logistics. The electric grid, interconnection, electric bills. Sustainability, public policy, government regulations, incentives, legal issues, community issues. Financial models.

CEE 501-020–Automation and Robotics in Construction
Introduction to construction automation and robotics; Human-machine interactions; Localization, pose estimation, navigation, and manipulation of construction robots in unstructured environments; tele-operated construction robots; Autonomous construction robots; Augmented Reality interfaces for construction robots; Rapid prototyping of construction robots and automation systems; Examples and case studies from construction.

CEE 555–Sustainability of Civil Infrastructure Systems
Life Cycle Cost Analysis and Life Cycle Analysis - Methods and Applications in Buildings; Building Energy Modeling and Simulation; Energy Management in Buildings; Impact of Building Occupants and Behavioral Challenges; Renewable Energy and Efficiency in Buildings; Existing Buildings and Technical/Social Challenges of Energy Retrofits; and Building Certifications (e.g., LEED).

CEE 530–Construction Professional Practice
Weekly industry speakers, two-semester team projects. Student teams work with contractor/owner client addressing industry problem as volunteer consultants. Teams contact client, select client problem, develop work plan. teams perform consulting work, prepare/present written/oral reports to class, client.

CEE 531–Construction Cost Engineering
Cost engineering for construction organizations, projects, and operations. Construction financing; break even, profit, and cash flow analyses; capital budgeting. Equipment cost and procurement decisions. Construction financial accounting, cost accounting, cost control systems, data bases. Cost indices, parametric estimates, unit price proposals, measuring work and settling claims.

CEE 532–Construction Project Engineering
The course covers the fundamentals of project-based organization, project delivery systems, resource management focusing primarily on human aspects, organizational behavior and culture, change and interface management, productivity measurement and

analysis, and construction safety and ergonomics. Examples and case studies from construction are used to help students' learning.

CEE 534–Construction Engineering, Equipment, and Methods
Major construction equipment and concrete construction. Selection of scrapers, dozers, cranes, etc., based on applications, methods, and production requirements. Power generation, transmission, and output capacity of equipment engines. Calculation of transport cycle times. Concreting methods including mixing, delivery, and placement. Design of forms for concrete walls and supported slabs.

CEE 535–Excavation and Tunneling
Selection of methods of attack for excavation of tunnels and deep vertical-sided openings. Tunneling procedures based on behavioral characteristics of soil and rock. Study of tunnel boring machines, shielded and drill and blast operations, linings. Deep excavation procedures related to support of excavation systems, methods of installation and dewatering.

CEE 536–Critical Path Methods
Construction project planning, scheduling, and control, using activity-on-arrow, activity-on-node, and overlapping network models. Start, finish, float, critical path calculations. Probabilistic activity durations, PERT concepts, merge event bias. Time-cost tradeoff resource allocation and leveling algorithms, cost-schedule integration, computerized control systems. Case studies, term project.

CEE 537–Construction of Buildings
Material selection, construction details, manufacture, fabrication, and erection of building structures using steel, light wood, timber, cast-in-place concrete, precast concrete, and masonry; and materials for roof, floor, and wall surfaces. Field trips to fabrication plants and construction sites.

CEE 538–Concrete Construction
Selection of concrete, batch design, additives, and batch plant. Structural design, construction of concrete formwork for buildings, civil works. Transporting, placing, and finishing equipment and methods. Plant and on site precasting and prestressing methods and field erection. Sprayed, vacuum, and preplaced aggregate concrete applications. Industrialized concrete systems. Concrete grouting, repair.

CEE 630–Directed Studies in Construction Engineering
Independent research under the direction of TCMP faculty leading to a written report (3 hr credit) or a Master's Thesis (6 hr credit), and an oral presentation.

CEE 631–Construction Decisions Under Uncertainty
Construction project and organization decisions for the uncertain future. Selection of construction methods, equipment, contract, markup, and financing alternatives having the highest expected values. Uses decision theory, competitive bid analysis, probabilistic modeling and simulation, and multiple regression analysis in managing construction.

CEE 930-020-Construction Industry Institute Best Practices
Introduction to the Construction Industry Institute (CII) Best Practices defined and developed by CII over the last 25 years. Current professional and practice issues in the construction industry. The course covers the majority of CII Best Practices, such as Front End Planning, Zero Accident Techniques, Constructability and Materials Management. Lectures focus on Best Practices or practice, and critical issues facing the construction industry.

CEE 930-028-Engineering Process Modeling and Risk Analysis
Engineering complex systems, models and simulation. Probabilistic aspects of simulations. Data collection and selection of input distributions. Design of experiments, input and output analysis and interpretation. Random number generators, variate and process generation. Monte Carlo simulation models. Activity cycle diagrams. Cyclone-EZStrobe-Stroboscope networks. Variance reduction techniques, antithetic sampling, common random numbers. Parametric analysis. Single system output analysis and multiple system comparison. Applications from on-site construction, off-site manufacturing, tunneling, earthmoving, mining, land, air, and marine transportation systems.

CEE 990–Dissertation/Pre-Candidate
Election for dissertation work by a doctoral student not yet admited to status as Candidate.

CEE 995–Dissertation/Candidate
Election for dissertation work by a doctoral student who has been admitted to status as Candidate.

GRADUATE FACULTY

John G. Everett (Lecturer, PhD 1991, Massachusetts Institute of Technology), occupational health and safety, ergonomics, building construction, equipment and methods, field operations, labor relations, productivity analysis and improvement. Teaches CEE 537, 538, 501-007.

Photios G. Ioannou (Professor, PhD 1984, Massachusetts Institute of Technology), computerized decision support systems, project and process simulation, project scheduling and control, building construction, design-construction integration, financial management, tunneling. Teaches CEE 536, 631, 930-028.

Vineet R. Kamat (Professor, PhD 2003, Virginia Polytechnic Institute and State University), Automation and robotics, and its applications in the construction, operation, and maintenance of civil infrastructure systems; Real-time visualization and its applications in construction process monitoring and control; 3D visualization of construction processes and products. Teaches CEE 531, 534, 501-020.

SangHyun Lee (Associate Professor, PhD 2006, Massachusetts Institute of Technology), Understanding and management of construction dynamics through the design and development of mechanisms, models, and systems that integrate automatic data acquisition, computer simulation, and visualization, particularly in mega construction projects. Teaches CEE 532, 930-020.

Carol C. Menassa (Assistant Professor, PhD 2009, University of Illinois at Urbana Champaign), Sustainable civil infrastructure systems; understanding and modeling the impact of occupants on energy use in buildings, and developing decision frameworks to assist in building operations and management; as well as, sustainable retrofit decisions. Teaches CEE 431, 530, 555.

ADDITIONAL INFORMATION

Send inquiries to Ms. Jessica Taylor (Graduate Coordinator) at jrand@umich.edu or to Professor Vineet R. Kamat (Program Advisor) at vkamat@umich.edu. Mailing Address: Department of Civil and Environmental Engineering, 2340 G.G. Brown Building, University of Michigan, Ann Arbor, MI 48109-2125. Phone: (734) 764-4325. Fax: (734) 764-4292. Access additional information on the TCMP at http://tcmp.engin.umich.edu.

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