

THE UNIVERSITY OF MICHIGAN

GRADUATE PROGRAM

Construction Engineering and Management

DEPARTMENT OF
CIVIL AND ENVIRONMENTAL
ENGINEERING

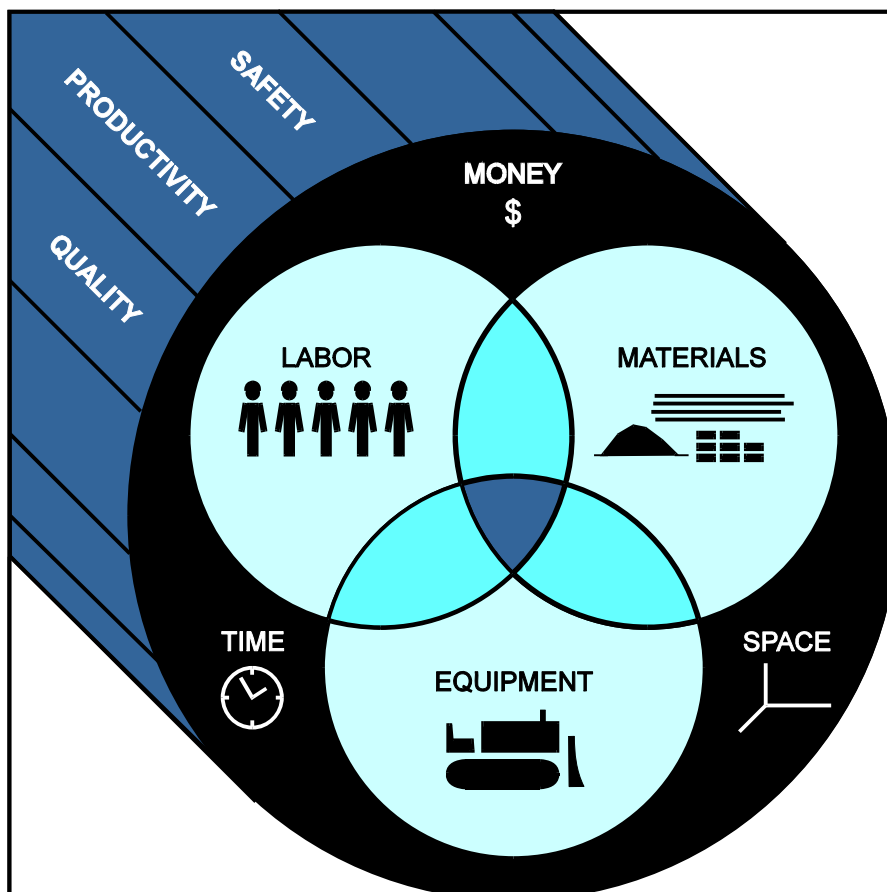
The Master of Science in Engineering program in Construction Engineering and Management, established in 1954, pioneered construction graduate education. Graduates lead construction engineering and management organizations throughout the world. The Master of Engineering program in Construction Engineering 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 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 – CONSTRUCTION ENGINEERING AND MANAGEMENT

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.

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| 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 Seminar | 3 hr |
| Graduate civil engineering construction electives | 9 hr |
| Minor concentration electives | 6 hr |
| Program elective | 3 or 4 hr |
| | <hr/> |
| | 30 or 31 hr |

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.

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|---|------------|
| CEE 531–Construction Cost Engineering | 3 hr |
| CEE 532–Construction Management and 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 mathematical programming elective | 3 hr |
| Program elective | 3 or 4 hr |
| | <hr/> |
| | 30 - 34 hr |

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.

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) and 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 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). Students may enter the graduate program in either the Fall or Winter Term.

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 Construction Program Advisor.

PhD DEGREE PROGRAM

The PhD program 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. The PhD program requires at least 21 credit hours of coursework beyond a Master's degree, not including independent study, to prepare the student for research in a specific area of Construction Engineering and Management. Students without a Master's degree from the University of Michigan may need to take additional courses to obtain the broad knowledge in Construction Engineering and Management expected of a University of Michigan PhD.

Research by University of Michigan faculty and PhD students in Construction Engineering and Management has included the following topics:

- Context-Aware Computing in Construction
- Post-Disaster Building Damage Reconnaissance
- Visualization of Construction Operations
- Object-Oriented, Graphical, Interactive Simulation
- Integrating Activity Planning and Process Simulation
- Knowledge-Based and Case-Based Planning
- Geologic Prediction Models for Tunneling
- Evaluation of Subsurface Exploration Programs
- Average-Price Competitive Bidding
- Optimal Capital Structure for Privately-Financed Infrastructure
- Dynamic Risk-Sensitive Decision Processes
- Resource Leveling Algorithms for Scheduling
- STROBOSCOPE: State- and Resource-Based Simulation
- Evaluation of Pilot Tunnels as an Exploration Strategy
- Overexertion Injuries in Construction
- Constructor Equipment Capacity in a Competitive Market
- Time-Lapse Video Applications in Construction
- Computerized Cost Estimating System for Design Decisions
- Advanced Construction Technology Information System
- Construction and Maintenance under Budget Constraints
- Evaluation of Privately-Promoted Infrastructure Projects
- Analysis of Union and Nonunion Construction
- Scheduling Repetitive Unit Construction
- Human Error in Structural Design and Construction
- Prioritization of Historic Buildings for Conservation
- RSM: Repetitive Scheduling Method
- Matched Simulation Experiments for Comparing Alternatives
- Motivation of International Construction Workers
- Construction Automation and Robotics
- Construction Manpower Planning for Developing Countries
- Advanced Building Technology Matrix System
- Costs of Accidents and Injuries in the Construction Industry
- Comparative Cost of Multi-Unit Residential Fire Separations
- CO³ Construction Congestion Cost on Highways
- Physiological Demands of Construction Work
- Electronic Photographs for Roofing Design Review System
- Time/Cost Simulation of Projects with Correlated Activities
- Planning and Scheduling Space Use on Construction Sites
- Substance Abuse Among Construction Workers
- Time/Cost Tradeoff where Activities Share Costs
- Analysis of Competitive Bidding Markets and Competition
- Vibration in Hammer Handles
- Spatial Variables in Bricklayer Productivity and Ergonomics
- Productivity and Ergonomics of Drywall Joint Finishing
- Quantitative Models for Predicting Pavement Performance
- Organizational Cultures in Engineering and Construction
- Video-Assisted Crane Operations
- Traffic control in flagged work zones
- Ergonomic Analysis of Construction Tasks
- Experience Modification for Workers' Compensation Insurance
- Learning Curve Predictors for Construction Field Operations
- Highway Construction Work Zone Safety
- Cost, Schedule, Time Variances and Control
- Infrastructure Management Decisions

THE UNIVERSITY OF MICHIGAN – CONSTRUCTION ENGINEERING AND MANAGEMENT

GRADUATE CIVIL ENGINEERING CONSTRUCTION COURSES

All courses, except CEE 431, are 3 credit hours. CEE 431 is 4 credit hours. All may be used for graduate credit for 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 530–Construction Professional Practice Seminar

Weekly industry speakers, two-semester team projects. Student teams work with contractor/owner client addressing industry problem as volunteer consultants. First semester (1 hr credit): teams contact client, select client problem, develop work plan. Second semester (2 hr credit): teams perform consulting work, prepare/present written/oral reports to seminar, 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 Management and Project Engineering

Project, company organization. Manpower planning, procurement; union, non-union construction. Job site layout. Material, equipment procurement. Construction operation planning, supervision, measurement, analysis, improvement, automation, robotics. Dimensions of performance: safety, quality, quality of work life, productivity, innovation. Examples and case studies from construction.

CEE 533–Advanced Construction Systems

Human-machine interactions. Automation and robotics. Ergonomics, job analysis, and job design. Work physiology, environmental factors. Occupational health and safety with emphasis on underlying causes and prevention of illnesses and injuries rather than on regulation. Risk, safety, and loss management.

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 551–Rehabilitation of Constructed Facilities

Infrastructure needs. Rehabilitation studies of buildings, underground construction, bridges, streets, and highways: types of distress; numerical condition surveys for foundation, structural, and functional deterioration; design criteria; materials and techniques; predictive performance models; evaluating alternatives; data bases; maintenance; management.

CEE 630–Directed Studies in Construction Engineering

Independent research under the direction of CE&M 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 633–Construction Management Information Systems

Automation of engineering and management functions using modern application development systems and end-user programmability built into advanced engineering and productivity applications. Fundamentals of object oriented programming. Interoperability and information exchange. Context-aware information access. Students design and implement computerized systems and apply to engineering problems and case studies.

CEE 830–Construction Engineering and Management Seminar

Assigned reading and student reports on problems selected from the field of Construction Engineering and Management. For PhD students to analyze and critique construction research literature and to learn research methods applicable to PhD research.

CEE 930–Construction Engineering Research

Selected work from a wide range of construction engineering areas including planning, equipment, methods, estimating and costs. Offered to post-MSE students in the PhD program, who have not yet taken the qualifying exam.

CEE 990–Dissertation/Pre-Candidate

Election for dissertation work by a doctoral student not yet admitted to status as Candidate.

CEE 995–Dissertation/Candidate

Election for dissertation work by a doctoral student who has been admitted to status as Candidate.

THE UNIVERSITY OF MICHIGAN – CONSTRUCTION ENGINEERING AND MANAGEMENT

DUAL MASTER'S DEGREE PROGRAMS

The Construction Engineering and 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.

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 (but not engineering technology programs or their equivalent) 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 412), Construction Contracting (CEE 431), and Soil Mechanics (CEE 445).

Structures courses taken in an Architecture program satisfy the CEE 412 requirement. With proper planning, CEE 351, CEE 431, and CEE 445 can be included in University of Michigan B Arch and M Arch programs.

To be admitted directly into the PhD program, an applicant will normally hold a Master's degree in Construction Engineering and Management, or its substantial equivalent.

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 530, CEE 532, CEE 534, CEE 536, CEE 537.

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 431, CEE 536, CEE 631.

Vineet R. Kamat (Assistant Professor, PhD 2003, Virginia Polytechnic Institute and State University), 3D visualization of construction processes and products, CAD applications in construction, construction operations design using modeling and simulation, computer applications and information technology in construction, computerized decision support tools. Teaches CEE 431, CEE 531, CEE 633.

ADDITIONAL INFORMATION

Send inquiries and requests for admission application forms and the College of Engineering *Bulletin* to the Program Advisor, Photios G. Ioannou, Department of Civil and Environmental Engineering, 2340 G.G. Brown Building, University of Michigan, Ann Arbor, MI 48109-2125. Phone (734) 764-8495. Fax (734) 764-4292. E-Mail: photios@umich.edu. The *Bulletin* is mailed free of charge within the United States. Foreign airmail costs \$10. Access information on CE&M at www.cem.umich.edu, the *Bulletin* at www.engin.umich.edu/students/bulletin/ and *Course Catalog* at www.engin.umich.edu/courses/.

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