INFRASTRUCTURE MANAGEMENT AND SECURITY AREA OF STUDY
Zachry Department of Civil Engineering
Texas A&M University

INTRODUCTION
Large-scale, distributed infrastructure systems such as communications, power, water supply, flood control, waste management, industrial, commercial, recreational, transportation, other public facilities, commercial facilities, and industrial facilities form the basis for much of modern society. Planning and managing these systems of systems presents a major challenge for Civil Engineers. In addition to understanding the behavior of infrastructure components individually (e.g., understanding a single bridge), we must understand how they interact and behave as a system (e.g., the Texas highway system). This requires an understanding of not only the technical aspects of infrastructure at which Civil Engineers excel, but also an understanding of the social, economic, and political context within which infrastructure problems exist and the management methods that can be useful within this context.

VISION
The vision of the infrastructure management and security area within the Department of Civil Engineering at Texas A&M University is to educate the next generation of engineers and researchers who will plan for and manage the infrastructure systems that civil engineers design, construct, and operate and who will lead the research efforts needed to improve infrastructure planning and management within Texas, the U.S., and the rest of the world.

MISSION STATEMENT:
The mission of the infrastructure management and security area within the Department of Civil Engineering at Texas A&M University is to:

- prepare graduate students so they will be able to plan for, operate, and manage the facilities and public works that civil engineers typically design and construct within the organizations responsible for funding such work;
- prepare graduate students so they will be equipped to lead the international research effort to improve society’s understanding of and capability for planning and managing infrastructure systems;
- educate graduate students so they are capable of completing appropriate information management and decision support activities required to support infrastructure management;
- educate graduate students so they are capable of assessing the vulnerability of infrastructure systems to human-induced and natural hazards, planning preparedness measures for infrastructure systems facing these hazards, and leading the engineering response to restore infrastructure services after these disasters;
- educate graduate students so they are capable of defining the condition of existing facilities through inspection techniques, analyzing citizen contact data, and using appropriate non-destructive testing and remote sensing techniques; and
- develop the knowledge required to address civil engineering infrastructure facilities and public works problems for the State of Texas.

AREA GOALS:
To meet these goals, the faculty will:

- provide courses that integrate scientific and engineering knowledge together with constraints from social, economic, and political factors;
- conduct the highest quality research in non-destructive testing, remote sensing, infrastructure assessment, infrastructure asset management, and infrastructure security;
- provide mentoring and educational opportunities to prepare students in the Ph.D. program to pursue research careers within academia, private corporations, and government agencies;
- promote the highest academic scholarship.
MAIN FOCUS AREAS OF THE PROGRAM:
- Non-destructive testing
- Remote sensing
- Geographic Information Systems
- Infrastructure reliability analysis
- Probabilistic Risk Analysis for complex infrastructure networks
- Decision support systems for complex systems
- Management in government agencies
- Contracting for and managing engineering and design services
- Funding and investment analysis in public agencies

DEGREE PROGRAMS
The following pages outline the degree programs in the Infrastructure Management and Security area. The Master’s of Engineering degree is intended to be a terminal, professionally-oriented degree for those seeking specialization in infrastructure management and security before entering the workforce. The Master’s of Science degree is intended for those who wish to conduct research in infrastructure management and security, either in preparation for entering a Ph.D. program or as preparation for entering the workforce. The Ph.D. degree is intended for those who plan to pursue a research career in the area of infrastructure management and security. This degree requires the completion of a dissertation in which original, rigorous research is completed. The Doctor of Engineering degree is intended for individuals preparing for professional engineering careers in business, industry and the public sector who seek education beyond the master’s degree level. The D.Eng. Program emphasizes engineering practice, public service and the development of leadership potential, not basic research. The Doctor of Engineering degree program is administratively managed by the Academic Dean's office in the Dwight Look College of Engineering.
The Doctor of Philosophy degree is a research degree requiring a minimum of 94 credit hours of approved courses and research with 64 of those credit hours occurring after completion of a M.S. degree. The degree also requires the student to complete a series of examinations (qualifying examination, preliminary examination, and dissertation defense) and submit a dissertation to the University. This dissertation is expected to make a substantial contribution of new knowledge. The purpose of the degree is to prepare students to pursue a research career in infrastructure management and security. Students interested in practice-oriented study beyond a M.S. or M.E. degree should consider the Doctor of Engineering degree.

There are three main areas of concentration within the PhD program in infrastructure management and security: infrastructure management, infrastructure security, and engineering & infrastructure policy. These concentration areas are intended to provide guidance on the types of projects and organization of coursework and the committee. However, there will likely be substantial overlap between the concentration areas in any given PhD program. However, each student should have a discernable primary focus in one of the concentrations. In all cases, the focus is on infrastructure systems (e.g., power distribution systems), not individual elements of infrastructure systems (e.g., steel lattice support towers). Ph.D. research focused on individual elements on the systems is best supported through other areas in the Zachry Department of Civil Engineering.

Because infrastructure management and security is a broad area and the program of each student is expected to be unique, the course requirements for the PhD program are flexible. However, there is a minimum set of required courses. All of the courses required for the M.S. degree in Infrastructure Management and Security or the equivalent at another university must be completed. If these courses were not completed as part of M.S. degree program, they will be required either as background that does not count towards the required 64 credit hours or, in some cases, as part of the required credit hours. The advanced courses required are specific to the concentration area within Infrastructure Management and Security as listed below. Beyond these minimum requirements, the courses to be completed are arranged in consultation with and by the approval of the PhD committee.

**Infrastructure Management**
The infrastructure management concentration focuses on developing and improving the methods used for managing infrastructure systems. These methods could include both quantitative and qualitative approaches, and examples of research in this concentration could include development and testing of quantitative decision support systems as well organizational studies seeking to understand issues related to the implementation of infrastructure management tools. Students choosing this option will likely take considerable coursework in management methods and quantitative decision modeling from the Mays Business School and/or the Industrial and Systems Engineering Department in addition to domain-specific Civil Engineering courses.

**Required Courses for the Infrastructure Management Area**
BUSH 666: Advanced Public Management
BUSH 668: Budgeting in the Public Sector (if not taken in the M.S. program)
BUSH 671: Science, Technology, and Public Policy (if not taken in the M.S. program)
INEN 622: Linear Programming
INEN 623: Nonlinear and Dynamic Programming
INEN 627: Engineering Analysis for Decision Making
INEN 689: Special Topics in Decision Analysis
STAT 632: Statistical Decision Theory
Infrastructure Security
The infrastructure security concentration focuses on assessing the risk and impacts of natural and human-induced hazards on infrastructure systems, on preparing for these hazards, and on technical issues related to the recovery from these hazards. The hazards addressed in this concentration include, but are not limited to, technological failures, terrorist attacks, hurricanes, earthquakes, tornadoes, floods, and winter storms. Because the occurrence of these hazards as well as their impacts when they do occur are inherently random, substantial coursework in statistics and probability modeling as well as coursework related to the hazard(s) being addressed is expected. Research in this area can make contributions to (i) modeling approaches, (ii) the understanding of infrastructure security, or (iii) both of these.

Required Courses for the Infrastructure Security Area
CVEN 689: Uncertainty Modeling for Engineering Management and Policy (Guikema)
PLAN 616. Analyzing Risk/Hazard and Public Policy
BUSH 650: National Security Law
BUSH 651: National Security Policy
STAT 632: Statistical Decision Theory
STAT 647: Spatial Statistics
STAT 659: Applied Categorical Data Analysis
STAT 673: Time Series Analysis I

Infrastructure Policy
In special cases, students may be able to pursue a Ph.D. in Infrastructure Management and Security that is focused on policy issues. The coursework for this concentration area is very flexible. The infrastructure policy concentration focuses on developing knowledge and experience in public policy issues related to planning, funding, and maintaining infrastructure systems as well as infrastructure policy issues surrounding preparedness for and recovery from human-induced and natural disasters, all as viewed from a technical engineering perspective. Students choosing this concentration area will have a substantial amount of interaction with the Bush School of Government and Public Service, including considerable coursework in the Bush School and likely representation from the Bush School on the dissertation committee. This concentration is intended primarily for students who plan to pursue a research-oriented career or a public service career in infrastructure in the U.S. Dissertation research in this area will likely include engineering analysis of an infrastructure problem or management approach in support of deep, fundamentally new analysis of an important public policy issue. The exact coursework and members of the dissertation committee will be arranged depending on the focus on the dissertation research and goals of the student.
The Doctor of Engineering degree program is administratively managed by the Academic Dean's office in the Dwight Look College of Engineering, and as such, specific requirements are defined by that office. The purpose of the Doctor of Engineering (D.Eng.) Program is to prepare women and men to work at the highest levels of the engineering profession. This program emphasizes solving problems that arise in using technologies beneficial to mankind. However, those problems and their solutions frequently affect society in nontechnical ways. Therefore, technological advances implemented through business and industry require direction by persons possessing both high technical competence and professional understanding of the social, political and institutional factors involved. Graduates of the D.Eng. Program are uniquely qualified to fulfill that important role.

D.Eng. students each develop a program of study unique to their goals under the guidance of the Engineering Graduate Studies office, the Department of Civil Engineering Program Coordinator, and their committee. If the student focuses on infrastructure management and security, it would be expected that the student would complete their course of studying while focusing on one of the three main areas of concentration described in the PhD program: infrastructure policy, infrastructure management, and infrastructure security. The primary difference would be that the focus of the D.Eng. study would be the application of those techniques and methods described in the Ph.D. program rather than research to develop new approaches.