



# Vanderbilt

Department of Civil and  
Environmental Engineering



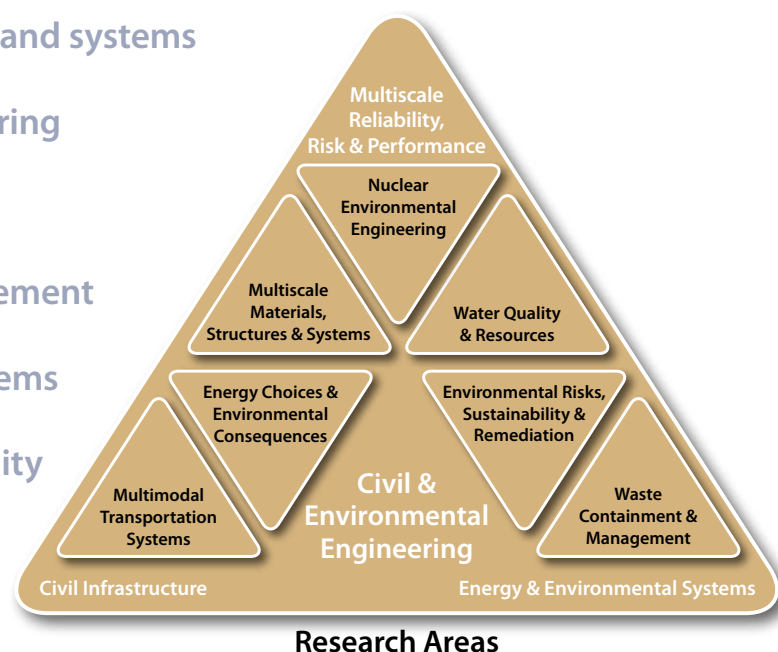
SCHOOL OF ENGINEERING



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### Degrees Offered

- Doctor of Philosophy (Ph.D.)
- Master of Science in Engineering (M.S.)
- Master of Engineering (M.Eng.)
- Bachelor of Engineering (B.E.)



Our program leading to the bachelor of engineering degree in civil engineering is accredited by the Engineering Accreditation Commission of ABET, [abet.org](http://abet.org).

## programs of study

### Undergraduate

Vanderbilt's Department of Civil and Environmental Engineering offers a broad-based education in civil and environmental engineering fundamentals, coupled with development of leadership, management and communications skills to establish a foundation for lifelong learning and flexible career development. This goal requires going beyond technical competence in a balanced education to develop future leaders in the fields of consulting, industry, business, law, government and research. Civil engineers must be able to face complex problems of modern society involving the development of physical facilities that serve the public while protecting the environment and preserving social values. Challenges facing civil and environmental engineers concern housing, transportation, pollution control, water resources development, industrial development, maintaining and advancing our nation's aging infrastructure and exploring space. Addressing these challenges with today's limited resources requires innovative and original ideas from highly skilled engineers.

Undergraduates majoring in civil engineering receive a strong background in mathematics, engineering, science and engineering design. The program also includes courses in economics, humanities, social sciences, resources management and public policy. Students participate in design teams and laboratory studies as well as classroom activities.



#### Contact

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### Graduate

At the graduate level, the department educates leaders in infrastructure and environmental engineering research and practice, with emphasis on the use of reliability and risk management. Reliability and risk management include engineering design, uncertainty analysis, construction and repair, life-cycle and cost-benefit analysis, information management and fundamental phenomena intrinsic to the understanding of advanced infrastructure and environmental systems.

The graduate program in civil engineering offers M.S. and Ph.D. degrees, with emphasis in the areas of structural engineering and mechanics and transportation engineering. The graduate program in environmental engineering offers the M.S. and Ph.D. degrees in the areas of environmental engineering and environmental science, with emphasis on contaminant behavior in the environment, waste management, nuclear environmental engineering, environmental remediation and environmental management and policy. Both thesis and non-thesis options are available at the M.S. level. The graduate programs in both civil engineering and environmental engineering also offer the master of engineering (M.Eng.), an advanced professional degree especially designed for practicing engineers wanting to pursue post-baccalaureate study on a part-time basis, and for engineers seeking greater emphasis on engineering design as part of graduate education.



#### Contact

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#### Contact

Director of Graduate Studies in Environmental Engineering  
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## multiscale materials, structures and systems

The Laboratory for Systems Integrity and Reliability is a 20,000 square-foot high-bay facility with state-of-the-art instrumentation for multimodal dynamic testing of myriad materials and machines. Students who work here with one-of-a-kind test-beds graduate as the most sought after engineers in the field. Our mission is to illuminate the complex ways in which materials and machines degrade and to predict reliability so that failure can be prevented. The goal is to develop new ways to sense, predict and control the structural integrity of the built environment, and to translate these technologies into practice to safeguard people and property. By using sophisticated instruments—such as electro-hydraulic vehicle simulators, wind turbine dynamic test rigs, high-speed 3-D laser velocimeters and systems for digital and infrared imaging—we can quantify how structural elements behave under realistic operating conditions. For instance, we study inertial sensing systems to detect icing in wind turbine blades, scanning laser systems for standoff detection of explosive devices and impact damage in helicopters using smart blades. We use full-scale airframe test beds to discover new ways to detect damage in composite aircraft that could reduce maintenance costs by an order of magnitude, and our diagnostic instrumentation for detecting cracks in our military vehicle test beds has been deployed to keep soldiers safe.

[engineering.vanderbilt.edu/lasir](http://engineering.vanderbilt.edu/lasir)

### Douglas ADAMS

Distinguished Professor and Chair of Civil and Environmental Engineering

I have always been fascinated with why materials and machines fail. My students and I conduct full-scale dynamic experiments to discover which sensors and signatures are first to warn of impending failure in a variety of structures in the built environment, including aircraft, automobiles and wind turbines. We then study these signatures to derive mechanistic models that explain why and how structures deteriorate. These models are extremely useful for prognostic health management, which is an automated process for scheduling maintenance of helicopters and other equipment to reduce



costs. Models can also be embedded into cyber-physical systems to make equipment safer, as in the case of an aircraft with a damaged actuator that is monitored and controlled to ensure the pilot can safely complete a mission. Our research in structural health monitoring has never been more important to the nation's energy and security needs because the power grid and military infrastructure are aging rapidly. Meanwhile, new systems with unknown failure patterns are brought online every day. Failure in these systems are not only costly, but our very lives may depend upon them.

### Çağlar OSKAY

Assistant Professor of Civil and Environmental Engineering

The research objective of our group is bringing understanding to nonlinear mechanical and functional response of multiscale materials and structures through computational modeling and simulation. Our research focus is on computational characterization of the failure response of material and structural systems that involve multiple temporal (fatigue loading) and spatial scales (structures made of

heterogeneous materials), development of computational methodologies for failure and fragmentation of composite systems subjected to extreme loading conditions including impact, blast and crushing loads, characterization of complex and hybrid composite systems and analysis of multiphysics problems that involve the effect of environment on mechanical response.



redicting the response of structural and material systems that operate in extreme environments and loads and designing materials with unique capabilities that can withstand such conditions are critical for the innovation of safe, sustainable, affordable and durable structural systems for a wide range of engineering fields including civil infrastructure, aerospace, defense and others. The current activities of the Multiscale Computational Mechanics Laboratory at Vanderbilt University include life prediction of aerospace composite structures subjected to cyclic loading, impact and blast response of structures coated with polyurea and polyurea-composites and embrittlement phenomena in metallic structures subjected to combined thermo-chemo-mechanical environments for future hypersonic air vehicles. We are conducting research by employing the computational facilities at our laboratory, as well as through research partnerships within and outside of Vanderbilt for experimental studies.

[my.vanderbilt.edu/mcml](http://my.vanderbilt.edu/mcml)





## multiscale materials, structures and systems

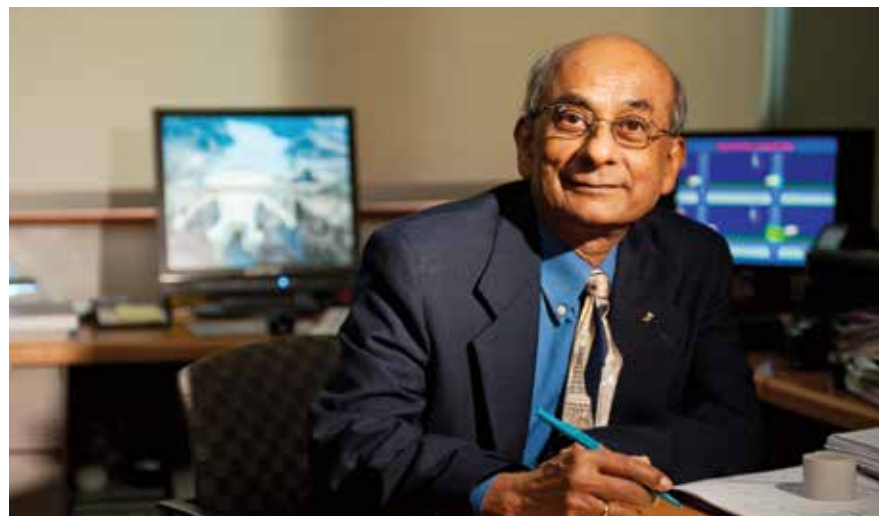
The Structures and Materials Laboratory has reinforced floors to withstand heavy loads and an overhead electric crane to facilitate both vertical and horizontal loads testing of model structures. A complete set of hydraulic loading equipment is available for load application. Apart from a range of sensors like LVDTs and load cells and strain pickups, associated data acquisition and processing systems are also available. The laboratory has a number of medium capacity equipment (Tinius Olsen, MTS, Fronny, etc.) for static and dynamic testing of material specimens and small-scale structural elements. For vibration testing, a medium-capacity LDS Shaker with controls and data acquisition and processing system is also available. The laboratory has facilities for fabricating test specimens and structural elements and is supported by a technical staff.

### P.K. BASU

Professor of Civil and Environmental Engineering  
Director of Graduate Studies in Civil Engineering

My most recent research interests are related to the following five topics: improvement of performance of short fiber-reinforced cementitious armor materials as well as multiscale modeling (MSM) and simulation, real-time monitoring of health and structural integrity of bridge structures using acoustic emission and other techniques, rapid extension of the life of highway bridge structures using bonded composite patch repairs, multidimensional modeling of complex structural systems with various types of irregularities and behavior of helicoidal structural systems. The first research topic is of great importance for the U.S. Department of Homeland Security and Department of Defense. As a representative volume element-based scheme will not work, a

new MSM scheme is being developed. The second research topic is focused on enabling the U.S. Department of Transportation to issue real-time warnings against compromises in bridge safety, followed by corrective actions. In these days of acute budget shortfall, with more than one-third of the nation's bridges being structurally deficient, the third research effort is developing a low-cost, rapid solution to extending the life of deficient bridges. The fourth research topic emphasizes improved computational efficiency through superior modeling and simulation schemes. The final research topic fills the need for better understanding of behavior and the need for efficient design methodology for helicoidal structures used in highway flyovers and other structures.



### Sankaran MAHADEVAN

John R. Murray Sr. Chair in Engineering  
Professor of Civil and Environmental Engineering  
Professor of Mechanical Engineering

My research interests cover both basic and applied research topics related to risk assessment and decision-making under uncertainty in engineering systems. Basic research interests include adaptive simulation methods for system and component reliability estimation, reliability and design optimization techniques for multidisciplinary systems, methods for material degradation modeling (fatigue/fracture, corrosion, concrete degradation), uncertainty and optimization methods for structural health monitoring and Bayesian methods for modeling and data

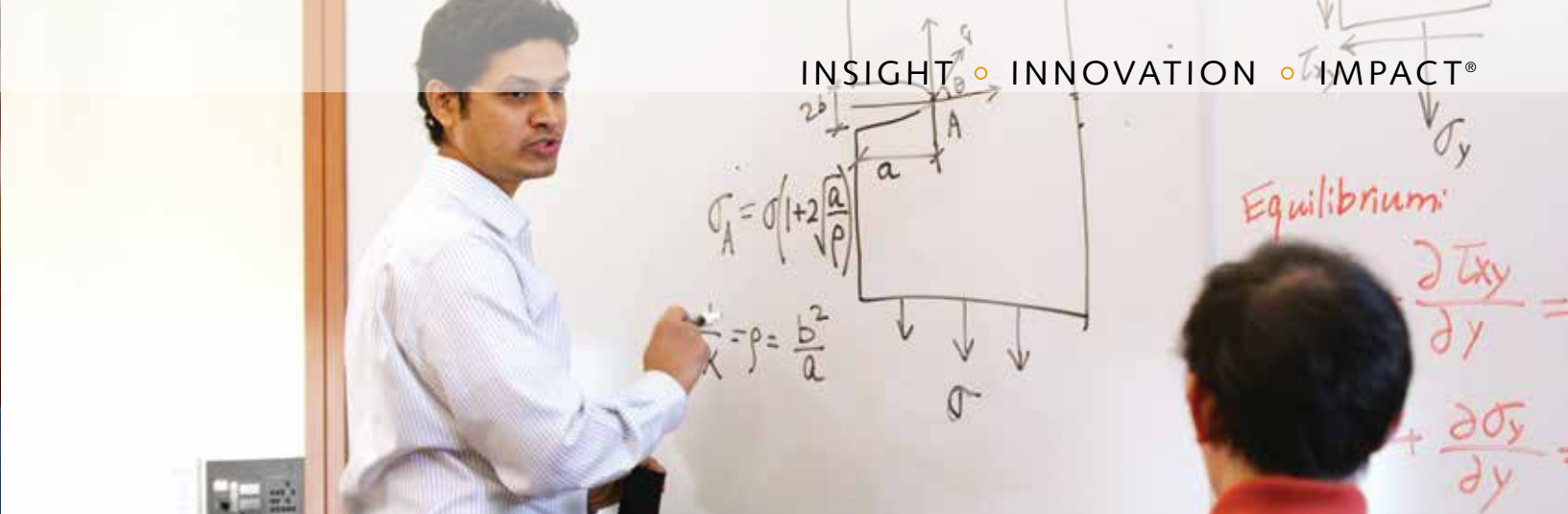


uncertainty assessment. My research projects investigate these methods for a large range of civil, mechanical and aerospace systems. This includes materials (metals, composites, cementitious materials), civil infrastructure (bridges, pavements, waterways structures, multistory buildings), mechanical systems/components (automobile components and joints, dynamics and energy dissipation, railroad wheels, micro-electro-mechanics devices) and aerospace systems/components (rotorcraft mast, aircraft engine components, aircraft wing and fuselage, space shuttle fuel tank, spacecraft thermal protection system panels, satellite systems, and space telescope components). My research in systems reliability and optimization also includes systems of systems with human interactions, such as transportation networks, security systems, emergency response and business supply chains.

direct a doctoral program with a focused study option on reliability and risk engineering and management, consisting of 20 professors from all engineering departments, mathematics, economics and business, and supported by many industry and government sources. The program currently has 17 graduate students. Most of the research is on model-based simulation; however, the fatigue-fracture research also currently includes crack growth experiments on metallic specimens in the laboratory.

[vu.edu/ceesystemsrisk](http://vu.edu/ceesystemsrisk)





## multiscale materials, structures and systems

The Multiscale Material Performance Laboratory includes facilities for fabricating, testing and characterizing cement-based composites. Strength of materials testing facilities include a Tinius-Olsen universal testing apparatus and an MTS testing machine. Physical and chemical characterization facilities include a nitrogen gas adsorption instrument for surface area and pore size measurement, a high resolution, thermogravimetric analysis-mass spectrometer (TA Instruments TGA-DSC 2920) and an inductively coupled plasma mass spectrometer (ICP-MS, Perkin Elmer ELAN 6000 Series DRC-II) with a laser ablation system. A state-of-the-art, high resolution, environmental scanning electron microscope (FEI Quanta 650 FEG) allows for imaging and analysis of pressure-sensitive samples such as cement-based materials and other environmental materials, including wet samples. A key feature of the system is the integration with energy dispersive spectroscopy for elemental analysis and electron-backscattered diffraction for mapping of crystal orientation and phase recognition. The lab also includes a dedicated, rack-mounted, 64-bit, quad-core, Dell server class computer with 16 gigabytes of RAM running Materials Studio 6.0 from Accelrys, a software environment for execution and visualization of molecular dynamics simulations with parallel processing capabilities.

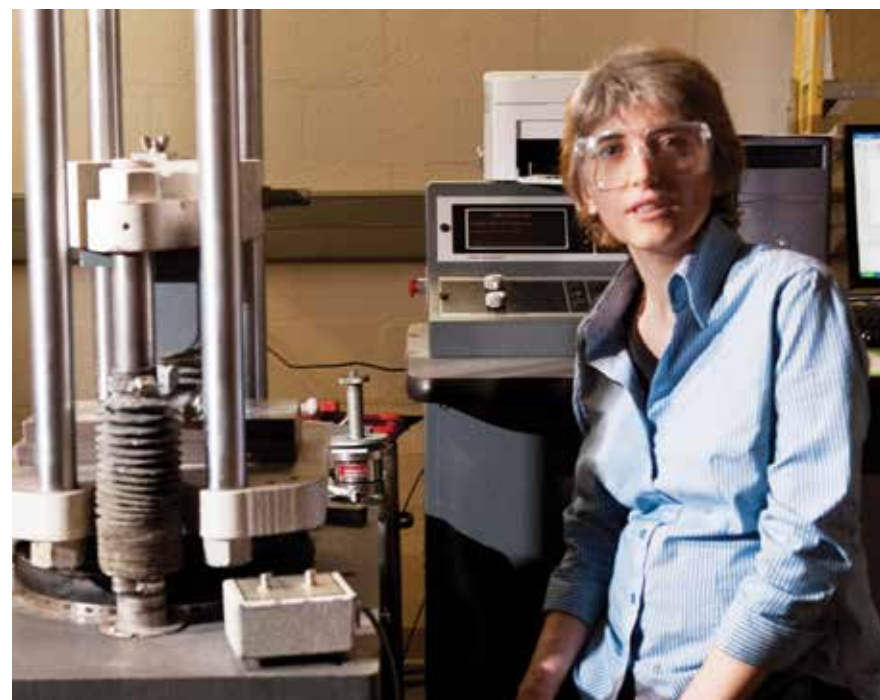
[vu.edu/ceestructmech](http://vu.edu/ceestructmech)

### Florence SANCHEZ

Associate Professor of Civil and Environmental Engineering

My research interests include multiscale experimental characterization and computational modeling of the performance and durability of cement-based composites. The research aims at understanding the complex processes associated with cement-based composites and the relationship between molecular-level chemical changes at internal interfaces and the macro-scale properties affected by those changes. The development of novel, cement-based composites with superior structural and functional properties and enhanced long-term durability occupies a central focus. Specific areas include: understanding the

mechanisms of interaction of nano-sized materials such as nanotubes, nanofibers and nanoparticles with cement pastes and their influence on the nano/microstructure and performance of the composites; elucidating the molecular structure and dynamics at solid-solid and solid-liquid interfaces that control reinforcement mechanisms in composites using molecular dynamics modeling; and understanding the controlling mechanisms of the weathering of nano/microfiber-reinforced, cement-based materials under various environmental conditions, mechanical stresses and weathering forces.



### Ravindra DUDDU

Assistant Professor of Civil and Environmental Engineering

My research interests are in the general area of computational solid mechanics with an emphasis on computational multiphysics and fracture mechanics. Topics include fracture in materials and structures, characterization of advanced materials such as composites and super-alloys, modeling of tectonic rift evolution for hydrocarbon exploration and numerical methods for evolving discontinuities. Specifically, I'm interested in understanding and predicting fracture and

damage processes involving multiple space and/or time scales within the framework of the finite element method. In addition, I'm interested in reactive transport modeling via residual-based variational multiscale stabilized finite elements. The computational methods and models I intend to develop are useful to study a wide array of applications in the areas of structural engineering and materials, geophysics, tissue and cell mechanics and energy research. Currently, I'm working on

simulating fractures in ice sheets in order to investigate iceberg calving from grounded tidewater and outlet glaciers using continuum damage mechanics. Large-scale simulations of disintegration of ice sheets, ice shelves and glaciers can help us estimate the global change in ocean levels due to melting ice and the resulting socioeconomic impacts.

[my.vanderbilt.edu/cpml](http://my.vanderbilt.edu/cpml)







## nuclear environmental engineering

Research in nuclear environmental engineering (NEE) at Vanderbilt includes work under contracts and grants from the Department of Energy's Office of Nuclear Energy and Environmental Management, the Tennessee Valley Authority and the Electric Power Research Institute. Ongoing NEE research projects include evaluating nuclear safety and environmental risk assessment impacts, along with the strategic communication challenges associated with the use of mixed-oxide fuel in commercial nuclear power plants. Also, safety, security, environmental and other societal criteria are critical to deciding what future nuclear fuel cycle research and development programs are best suited to meet the nation's needs. Other projects include the development of qualitative and quantitative environmental risk assessment tools, which take into account both radiological and chemical hazards, for use in evaluating the various options that exist for future nuclear fuel cycles.

### Steven KRAHN

Professor of the Practice of Nuclear Environmental Engineering

The emerging field of NEE is an area of research and practice that has aggregated over the past decade to meet the dual challenges of satisfying the growing needs of society for electric power while ensuring that stringent requirements in the areas of environmental protection and nuclear safety are met. Our research projects emphasize understanding the environmental and societal impacts of the nuclear fuel cycle comprehensively, ensuring that new or re-engineered nuclear processes work safely and in concert with the environment, minimizing the generation of radioactive waste, performing properly tailored risk

assessments and incorporating regulatory and stakeholder insights in a coordinated and timely manner. Such projects draw chiefly on expertise in the fields of systems, environmental, nuclear and chemical engineering, along with risk and policy insights. Recently, the secretary of energy named me to a technical and policy team evaluating programmatic improvements to nuclear safety culture initiatives within the department. Prior to joining the Vanderbilt community, I served as a deputy assistant secretary of energy for safety and security in the Department of Energy's Office of Environmental Management.



### James CLARKE

Professor of the Practice of Civil and Environmental Engineering  
Director of Graduate Studies in Environmental Engineering

Along with Steven Krahn, I co-direct graduate students pursuing the Ph.D. in environmental engineering in the area of NEE, as well as students working in the areas of waste management and contaminated site remediation. Prior to joining the Vanderbilt engineering faculty in 2000, I was the chairman, president and CEO of an internationally recognized consulting firm that specialized in the investigation and remediation of contaminated sites, risk assessment and industrial wastewater treatment. Since joining the faculty, my research has focused on risk assessment, both human health and ecological, environmental restoration approaches for the Department of Energy's former nuclear weapons complex and comparative risk assessment for selected nuclear fuel cycles.

As a former member of the Nuclear Regulatory Commission (NRC) Advisory Committee on Nuclear Waste and Materials, it was my role to lead decommissioning and risk-informed regulation. Currently, I serve as a consultant to the NRC Advisory Committee on Reactor Safeguards, the U.S. Environmental Protection Agency and the Department of Energy. I am a member of the American Academy of Environmental Engineers and Scientists and a board-certified environmental scientist.



My current research is on several topics within the broad area of environmental management and decision-making with a focus on the investigation and remediation of contaminated sites, risk analysis and performance assessment and confirmation for near-surface disposal of hazardous chemical and low-level radioactive waste. Specific projects include comparative risk assessment for selected nuclear fuel cycles, a systems approach to the design of near-surface disposal facilities, ecological assessment and monitoring, modeling the potential impacts of climate change on the performance of engineered cover systems and development of a modeling framework for the transport of contaminants across the ground water/surface water interface.

#### Additional Faculty

**Mark Abkowitz**  
Professor of Civil and  
Environmental Engineering

**David Kosson**  
Cornelius Vanderbilt Professor  
of Engineering

**Charles Powers**  
Professor of Environmental Engineering





## water quality and resources

The environmental laboratories within the civil and environmental engineering department include facilities for characterizing, analyzing and evaluating the fate and transport of emerging contaminants to include pharmaceuticals and engineered nanomaterials in the environment. Physical and chemical characterization facilities include a multigas adsorption instrument for surface area and pore size measurement, a high-resolution, thermogravimetric analysis-mass spectrometer (TA Instruments TGA-DSC 2920) and an inductively coupled plasma mass spectrometer (ICP-MS, Perkin Elmer ELAN 6000 Series DRG-II) with a laser ablation system. A state-of-the-art, high-resolution, environmental scanning electron microscope (FEI Quanta 650 FEG) allows for imaging and analysis of pressure-sensitive samples such as nanomaterials and other environmental materials, including wet samples. A key feature of the system is the integration with energy dispersive spectroscopy for elemental analysis and electron-backscattered diffraction for mapping of nanomaterial agglomeration site recognition. The environmental laboratory also includes a dedicated, rack-mounted, 64-bit, quad-core, Dell server class computer with 16 gigabytes of RAM running Materials Studio 6.0 from Accelrys, a software environment for execution and visualization of molecular dynamics simulations with parallel processing capabilities.

### Eugene **LEBOEUF**

Associate Professor of Civil and Environmental Engineering  
Director of Undergraduate Studies in Civil Engineering

My research interests focus on two primary areas: physicochemical processes of environmental systems and developing improved methods to manage and increase sources of hydro-based renewable energy. Our current National Science Foundation-funded efforts include an integrated experimental and modeling research framework structured around four objectives: advance characterization methods to link physicochemical and macromolecular characteristics of organic matter and the fundamental nanostructure of engineered nanomaterials with their macroscopic interactions, quantify the interactions of nanomaterials and natural organic matter by conducting quartz crystal microbalance attachment/detachment experiments, quantify the influence of natural organic matter on the transport of nanomaterials in porous media, and develop and experimentally validate a mathematical model capable of simulating nanomaterial transport in porous media. The second area of interest focuses



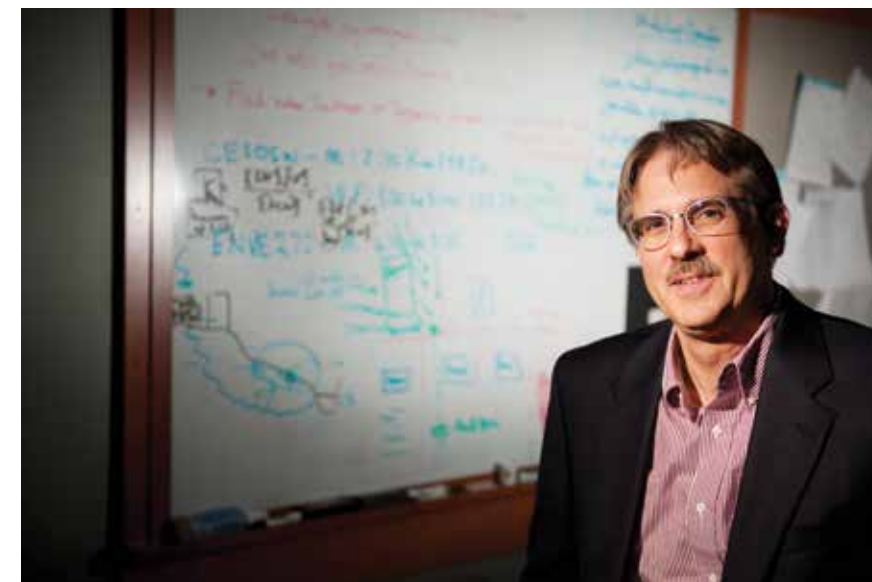
on sustainable-energy water systems, including optimization of multireservoir hydropower systems. The goal of this Department of Energy-funded research initiative is to apply state-of-the-art mathematical and modeling approaches for model reduction, linearization, and multi-objective optimization to multisystem hydropower operations that maximize energy production while minimizing environmental impacts.

### Alan **BOWERS**

Associate Professor of Civil and Environmental Engineering

I'm interested in biological and physical/chemical processes in the environment. This includes the kinetics of biodegradation and the role of uncertainty in the application of these processes to the design and operation of wastewater treatment operations. This is important to modeling biological treatment processes including the biodegradation of organics and the concurrent air-stripping of volatile

organics. Currently, I'm working on the fate of pharmaceuticals and personal care products (micropollutants) in the environment and in conventional waste treatment processes. In addition, my research group is examining the formation of magnesium-ammonium-phosphate (struvite) in wastewater systems where magnesium hydroxide is employed as an alkalinity booster.



As the human population continues to expand and consume resources at an ever-increasing rate, new risks continue to arise in the environment. Technological challenges, such as fracking to develop natural gas deposits, the discovery of apparently non-biodegradable micropollutants in the environment and the necessity to recycle our resources challenge the limits of knowledge on a daily basis. Our research group strives to understand the basic chemistry and biology involved in these problems and to develop new technologies for water and wastewater treatment like treating fracking wastes and pharmaceuticals and personal care products. In addition, we are evaluating novel chemistries to recycle critical resources such as struvite precipitation to recycle high-grade phosphorus from wastewater. Our environmental laboratories are well equipped to evaluate environmental processes from a fundamental standpoint. They include most standard environmental test equipment and instrumentation for monitoring radio-labeled tracers and measuring organic and inorganic pollutants in the environment such as GC-MS, ICAP and ion chromatography.

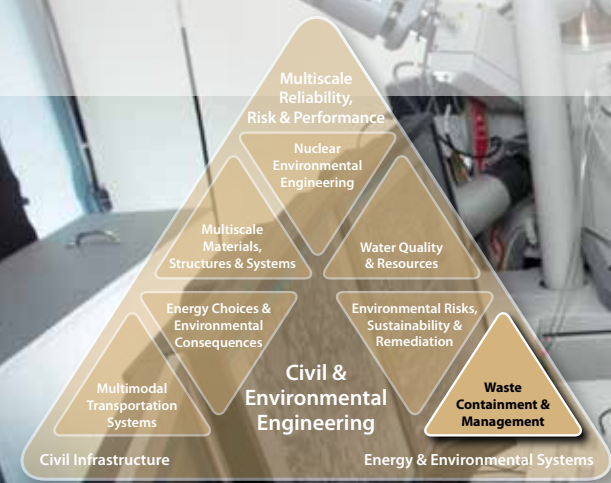
#### Additional Faculty

**Andrew Garrabrants**  
Research Associate Professor of Civil and Environmental Engineering

**George Hornberger**  
Craig E. Philip Professor of Engineering

**David Kosson**  
Cornelius Vanderbilt Professor of Engineering





## waste containment and management

**S**ustainable environmental management of waste from nuclear energy and industrial processes is a national challenge with tens of billions of dollars in annual expenditures. Our research provides basic knowledge and applied tools and technologies that allow decisions to be made that are sustainable, environmentally protective and cost effective. Achieving the needed balance requires research that includes thermodynamics and kinetics of contaminant fate and transport in natural and engineered systems, human health and environmental risk evaluation, development of practical tools and policies, and coupling with active engagement with diverse stakeholders. We carry out basic research and collaboration with national agencies (Environmental Protection Agency, Department of Energy, Nuclear Regulatory Commission), international partners and national laboratories, through the Consortium for Risk Evaluation with Stakeholder Participation and other programs. The laboratory backbone includes advanced instrumentation (mass spectroscopy, electron microscopy, chromatography, high performance computing, etc.) and dedicated staff, while the research programs also provide direct interaction with decision makers—all combined to form unique and exciting opportunities for graduate research.

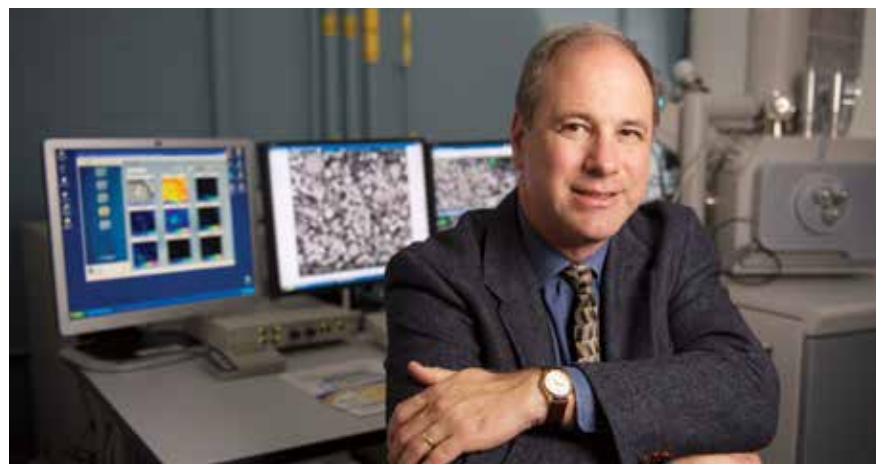
[vanderbilt.edu/leaching](http://vanderbilt.edu/leaching)  
[cresp.org](http://cresp.org)  
[CementBarriers.org](http://CementBarriers.org)

### David KOSSON

Cornelius Vanderbilt Professor of Engineering  
 Professor of Civil and Environmental Engineering  
 Professor of Chemical Engineering  
 Professor of Earth and Environmental Sciences

I focus on research in waste management and environmental remediation that allows new understanding of the fundamental behavior of chemical and radionuclide contaminants in wastes, engineered systems and the environment to impact major decisions and policy. For example, work in my research group in collaboration with other faculty and international partners has resulted in establishment of the U.S. EPA Leaching Environmental Assessment Framework, which is now being used for national policy decisions on the management of coal fly ash.

Research on improving remediation and waste treatment processes has changed the approaches being used at several Department of Energy sites formerly used for the production of nuclear defense materials. The Cementitious Barriers Partnership, a collaboration of several federal agencies, national laboratories and international partners formed under my leadership, is providing the tools necessary to predict the long-term performance of cement and concrete materials used in nuclear energy and nuclear waste management.



### Andrew GARRABRANTS

Research Associate Professor of Civil and Environmental Engineering

With nearly 20 years of experience in development of leaching protocols, interpretation methodologies and assessment models, primarily for inorganic constituents in hazardous, radioactive and mixed waste systems, my research focuses on advancing the development and acceptance of the Leaching Environmental Assessment Framework for environmental impact assessment of solid wastes and construction materials and reuse of the byproducts of energy production and industrial processes. I am a collaborator in the

development of the LeachXS and LeachXS Lite software packages designed for data management, visualization, modeling and assessment. Other research interests include release assessment approaches for semi-volatile organics in soil/cement mixtures (in-situ stabilized soils), physiochemical models for estimating source terms for risk assessment and risk evaluation, and leaching chemistry and long-term durability of cement-based solidification/stabilization (S/S) waste treatment and cementitious engineered

barriers for nuclear waste disposition. In addition to research, I'm actively involved in ASTM International, serving as chair of the D-34 committee on waste management, chair of the D-34.03 subcommittee on recovery and reuse and leader of the D-34.01.04 task group on waste leaching techniques. I also hold memberships in the American Institute of Chemical Engineers, American Society of Civil Engineers and the American Chemical Society.

[vanderbilt.edu/leaching](http://vanderbilt.edu/leaching)



### Additional Faculty

**Florence Sanchez**  
 Associate Professor of  
 Civil and Environmental Engineering





## multimodal transportation systems



## environmental risks, sustainability and remediation

### Janey **CAMP**

Research Assistant Professor of Civil and Environmental Engineering

I have a broad range of interests, but ultimately I'm interested in studying the interactions of nature and man-made systems utilizing geospatial technologies. This includes modeling future flooding and the potential impacts on communities and infrastructure systems to identify key risk areas. Using a holistic, all hazards approach, we can use risk management techniques to not just identify those key risk areas, but also consider future planning and adaptation strategies that may pose low-cost, high-reward opportunities

to assist in informed decision-making. I'm also strongly interested in sharing knowledge with the next generation on these issues by integrating engineering and geospatial technologies in K-12 education to prepare the next group of engineers and scientists to address the challenges of the future. In addition, I'm involved in several interdisciplinary projects focused on infrastructure system adaptation to climate change, risk management and also STEM integration into education.



#### Additional Faculty

**Mark Abkowitz**  
Professor of Civil and  
Environmental Engineering

**Robert Stammer**  
Associate Professor of Civil and  
Environmental Engineering

### Mark **ABKOWITZ**

Professor of Civil and Environmental Engineering

Professor of Engineering Management

Director of Vanderbilt Center for Environmental Management Studies

Enterprise risk management is emerging as a spotlight topic as our nation grapples with how to allocate resources across natural and man-made threats. My research focuses on developing analysis tools and management processes to help address four important questions: What can go wrong? How likely is it? What are the consequences? What can we do to reduce the threat? An equally compelling topic is the impact of extreme weather events on the ability of our nation's critical infrastructure to withstand the anticipated effects. My colleagues and I are involved in both improving our understanding of the impact of extreme weather events on infrastructure vulnerability and developing adaptation strategies that will overcome this challenge. In this age of information technology, there are exciting opportunities to combine geographic information technology, global positioning

systems and Web-based tools to develop sophisticated and visually appealing graphics that help travelers enhance their safety, security and efficiency. Our research group is a leader in this field. With events such as the nuclear disaster in Japan and difficulties in establishing a permanent repository for spent

nuclear fuel and high-level waste, I have been integrally involved in informing the debate through demonstrating the waste management consequences associated with different energy scenarios. Underpinning my work is a strong desire for interdisciplinary collaboration, through affiliation with colleagues in various

engineering disciplines, along with my counterparts in law, business, public policy, arts and sciences and education. Because today's problems are rarely defined along traditional lines, it is extremely important that these other perspectives are an integral part of the process for defining problems and searching for achievable solutions.

[vanderbilt.edu/vector](http://vanderbilt.edu/vector)



#### Additional Faculty

**James Clarke**  
Professor of the Practice of Civil and  
Environmental Engineering





# energy choices and environmental consequences

The future health and well being of humanity hinge in large part on smart production and use of energy, water and related resources, as these are central determinants of climate change, habitable space and human and ecological health. The Vanderbilt Institute for Energy and the Environment (VIEE) engages in research and education that directly link the social and behavioral sciences, physical sciences, engineering, law and policy, and that bear on energy and environmental decision-making by individuals and by public and private institutions. Specifically, VIEE research elucidates the relationships among individual, institutional and societal choices for energy production and use, and the impacts and benefits of these choices on the environment and health through links with climate, water quality, economics, social psychology and natural resources. A key aim of VIEE is to create a strong multidisciplinary undergraduate and graduate research and education program and to be an international leader in contributing to the resolution of critical issues by fostering links among diverse fields of human thought and action in unprecedented collaborations.

[vanderbilt.edu/viee](http://vanderbilt.edu/viee)

## George HORNBERGER

Distinguished University Professor  
Craig E. Philip Professor of Engineering  
Professor of Civil and Environmental Engineering  
Professor of Earth and Environmental Sciences

I am interested in how hydrological processes are affected by humans and in how human behavior is affected by hydrological processes. As risks of both flooding and water scarcity become more acute over time, there is grave concern that our infrastructure systems—water treatment facilities, pipelines, sewers, highways, bridges, dams, hydroelectric facilities, irrigation systems and other aspects of the built environment—will become more vulnerable and less resilient, leading to potentially catastrophic

consequences. Furthermore, under conditions of water scarcity, vulnerability can be exacerbated by approaches to allocate water among competing demands. For example, tradeoffs between hydropower and irrigation, or between biofuels and food, may lead to badly suboptimal adaptation. My current work on climate change and drought in Sri Lanka is aimed at understanding how adaptation decisions can be informed by interdisciplinary research.



## Charles POWERS

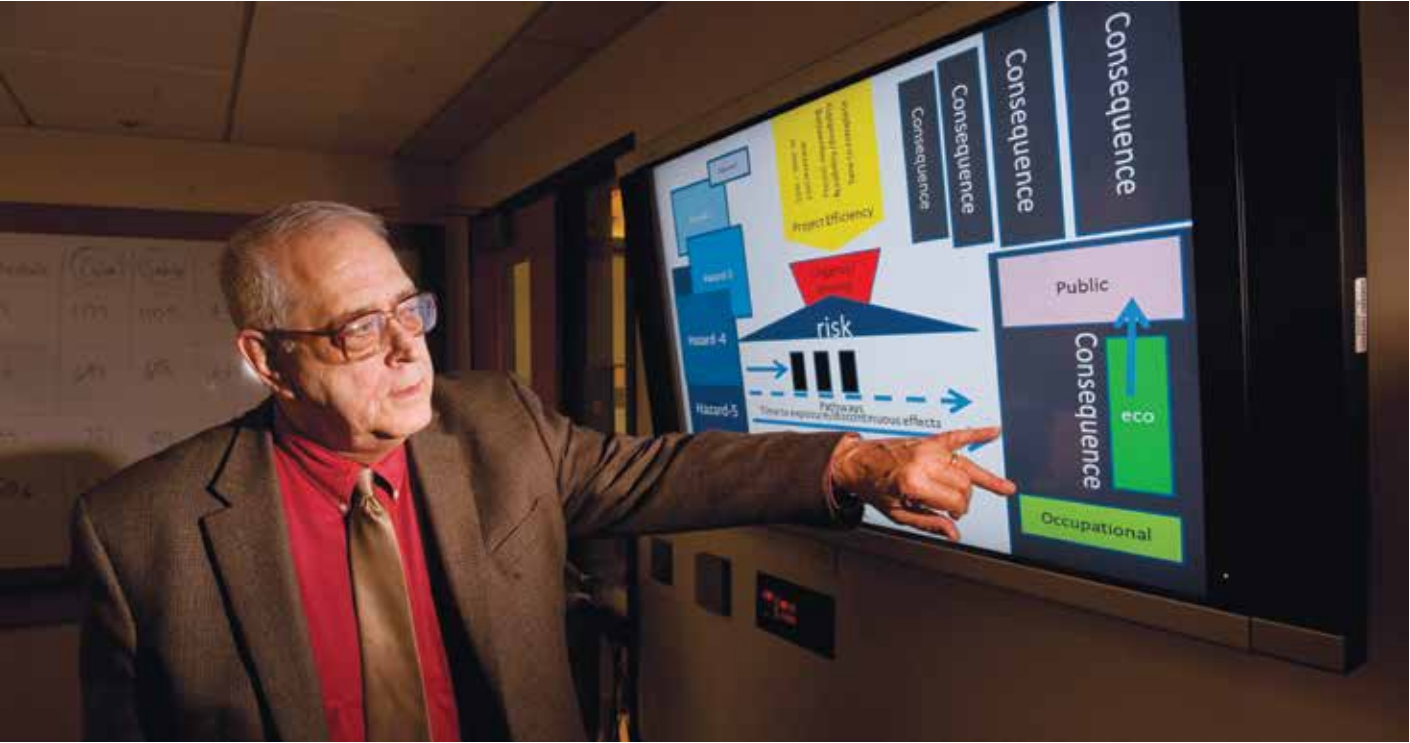
Professor of Environmental Engineering

I have focused my professional career on understanding and improving the complex technical, social and regulatory interfaces that affect environmental management and on defining the scientific and technical processes and procedures that make the development of technical information publicly credible. I research and have successfully implemented ways to form the contexts in

which such information actually facilitates risk management consensus. Recently I have led a multi-university effort to create a template to integrate the current regulatory regimes, so that even in this time of scarce resources the managerial and regulatory decisions at both the Oak Ridge Reservation and at the Hanford site in eastern Washington state better shape the priorities for more cost-effective and

sustainable cleanup of those complex former nuclear facilities. I also continue to define tools for the resolution of the ethical/legal dilemmas faced by professional practitioners in various fields including engineering, medicine, law, business and government.

[cresp.org](http://cresp.org)



### Additional Faculty

David Kosson  
Cornelius Vanderbilt Professor of Engineering





## construction management

The nature of the construction project is such that owners, contractors and designers progress from project inception to completion, while attempting to satisfy competing objectives. This results in high potential for conflict, changes and claims. In this environment, construction management software can provide a foundation to enable transparency, accountability and collaboration. The Construction Management Software Lab in Jacobs Hall hosts a suite of state-of-the-art software that is used by firms large and small to successfully execute projects. The software includes:

- e-Builder Project Management
- Sage Timberline Estimating
- Oracle Primavera Scheduling
- On-Screen Takeoff
- Hard Dollar Construction Estimating
- Bentley Structural Modeler V8i for Building Information Modeling
- Bentley RAM Structural System V8i

### Rolling Admissions

Students are admitted on a rolling basis each fall, spring and summer semester. For additional information, visit [vu.edu/constructionmanagement](http://vu.edu/constructionmanagement).

## Sanjiv GOKHALE

Professor of the Practice of Civil and Environmental Engineering  
Director of Graduate Program in Construction Management

My research focuses on the testing and assessment of minimally invasive technologies for pipeline condition assessment, repair and rehabilitation. Traditional rehabilitation and renewal methods for underground infrastructure often focus on first cost, rather than life-cycle costs. I have developed and tested a framework for a multi-attribute model that addresses the various objectives in underground infrastructure asset

management, through a life-cycle cost approach. In addition, I've developed a robust decision tool to assist the project team in evaluating and executing projects that are cost-driven. In defining the cost-schedule trade-offs, the decision tool has the capability to model all of the variables in a capital project execution plan that influence the cost-versus-schedule decisions.



The construction management program boasts a 100 percent career placement rate for both interns and graduates.





## teaching

### Robert **STAMMER**

Associate Professor of Civil and Environmental Engineering

To educate some of the best and brightest engineering students in the world regarding the importance of transportation engineering is both an honor and a challenge. There is no greater reward than introducing a new concept in class and recognizing by the student's facial expression that you have just implanted new knowledge. But, education is certainly a two-way street. I learn something new every class period by listening to my students. They are intelligent and inquisitive and they

educate me continually. Recognizing that you may have made a difference in their lives is one of the most rewarding aspects of my more than 30-year teaching career. As the department's career adviser, I help students plan their next career step after graduation and assist undergraduates with internship placement. Seeing the students mature from freshmen to highly successful graduates who make a difference through their professional careers is another significant benefit of being an educator.



### Curtis **BYERS**

Professor of the Practice of Civil and Environmental Engineering

Vanderbilt students are capable of learning the fundamental science underlying any engineering curriculum, but they need mentoring to understand how to use that fundamental knowledge to creatively solve the very real problems that engineers, and only engineers, can address. My role is to be one of their first mentors by transferring to them the insights and methods that I

learned from over 35 years of engineering practice and from those who mentored me. This universal process of one generation of engineers helping the next generation has resulted in the fantastic growth and sophistication of the engineered world. It is extremely rewarding to see these fine young engineers of Vanderbilt enthusiastically accept the challenges of their profession.



### Lori **TROXEL**

Associate Professor of the Practice of Civil and Environmental Engineering

Getting to know undergraduate engineering students at Vanderbilt has been very rewarding. It is a joy to be a part of their lives whether they know exactly what they want to do or they do not know why they are in engineering. Interaction with students in class and especially through the American Society of Civil Engineers (ASCE) is a way to teach not only engineering skills, but relational and

professional ones as well. In the classroom, I like to make sure each student is engaged in learning so I use discussions, hands-on examples and even competitions to teach. Introducing students to sustainability issues in civil engineering is a recent endeavor. I have the privilege of taking students to the U.K. in the summer to learn even more about this important issue.



Vanderbilt's chapter of ASCE is consistently ranked in the top student chapters nationwide and provides opportunities for professional development.



## centers and institutes

## Consortium for Risk Evaluation with Stakeholder Participation (CRESP)

cresp.org



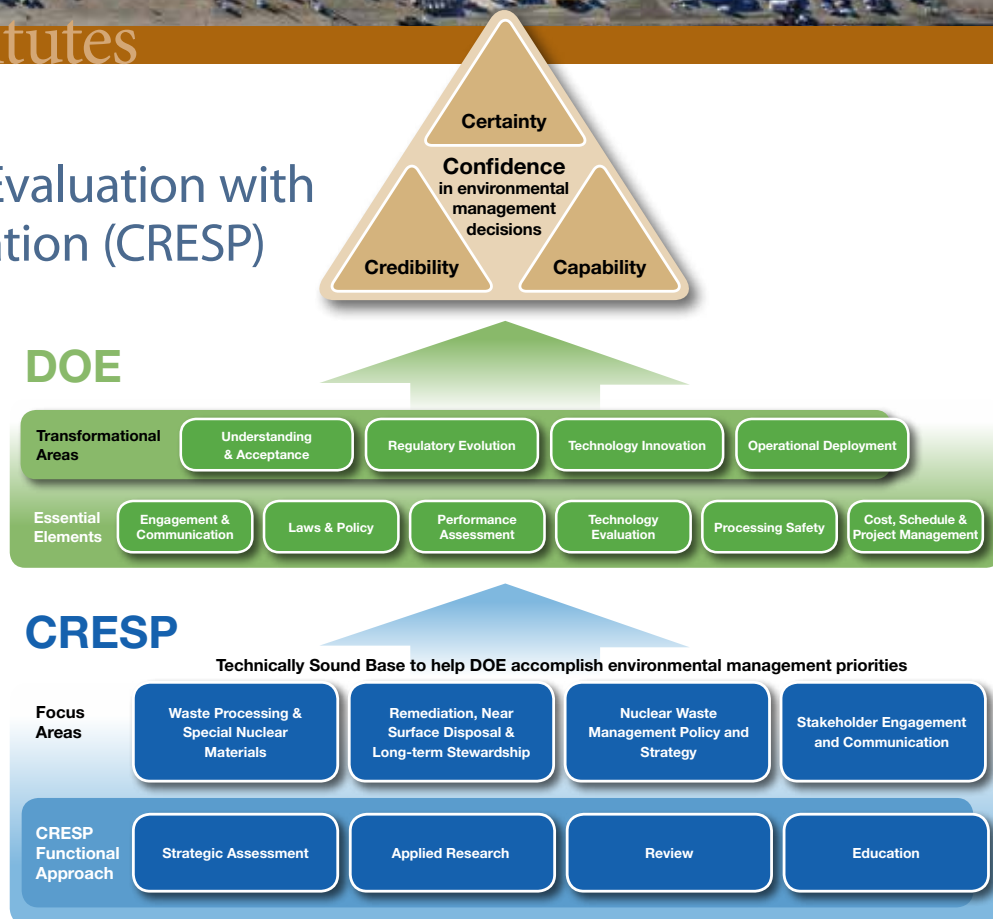
Kosson



Powers

Vanderbilt leads the Consortium for Risk Evaluation with Stakeholder Participation, which works to advance cost-effective, risk-informed cleanup of the nation's nuclear weapons production facility waste sites and management of potential future nuclear sites and wastes. This is accomplished by seeking to improve the scientific and technical basis for environmental management decisions by the Department of Energy (DOE) and by fostering stakeholder participation in that search. CRESP carries out multidisciplinary research, education and review in waste processing and special nuclear materials; remediation, near-surface disposal and long-term stewardship; nuclear waste management policy and strategy; and, stakeholder engagement and communication.

Principal Investigator David Kosson and Co-Principal Investigator Charles Powers lead the multi-university consortium that has served the DOE and its stakeholders since 1995, currently through a cooperative agreement (2006–2017) awarded to Vanderbilt University. The CRESP Management Board is comprised of technical, engineering, scientific, medical and policy experts from seven university consortium member institutions in addition to Vanderbilt: Georgia Institute of Technology, Howard University, New York University School of Law, Oregon State University, Rutgers–The State University of New Jersey, University of Arizona, and University of Wisconsin–Madison.



## Vanderbilt Engineering Center for Transportation Operations and Research (VECTOR)

vanderbilt.edu/vector

## VECTOR conducts research on:

- Geographical information systems for transportation
- Intelligent transportation systems
- Routing and logistics
- Hazardous materials transport
- Traffic engineering
- Highway safety
- Infrastructure adaptation
- Transportation risk management

## Vanderbilt Institute for Energy and Environment (VIEE)

vanderbilt.edu/viee

The Vanderbilt Institute for Energy and Environment facilitates innovative research, education and outreach to explore and solve modern environmental and energy problems. The institute promotes interdisciplinary work among law, business, the natural and social sciences, the humanities and engineering. The goals of VIEE are:

- To expand the understanding of energy and the environment by conducting basic and applied interdisciplinary research that will affect policy and management
- To build education programs that will provide rigorous and innovative curricula within current and new programs to attract exceptional and diverse students
- To build communication within and reach out beyond Vanderbilt to help impact the energy and environmental work of government agencies, businesses, academic institutions and communities

## Vanderbilt Institute for Nanoscale Science and Engineering (VINSE)

vanderbilt.edu/vinse

## VINSE conducts research on:

- Properties affected by nanoscale dimensions
- Atomic manipulation, coupling of properties at the nanoscale
- Controlled synthesis, fabrication and processing at the nanoscale
- Nanoscale precursors and assembly, nanostructure arrays, fullerenes, carbon nanotubes and organic nanostructures
- Quantum dots, quantum wires, quantum wells, superlattices
- Nanoelectronics, single electron electronics and devices, molecular electronics, quantum computing
- Nanomechanics, nanobiological function and life sciences
- Nanoscale instrumentation and characterization
- Nano-optics, photonic crystals with nanoscale structural fidelity

## Vanderbilt Center for Environmental Management Studies (VCEMS)

vanderbilt.edu/vcems/

The Vanderbilt Center for Environmental Management Studies was established to promote and develop interdisciplinary relationships focused on the impact of environmental engineering, management and law on environmental policy and practice. The center's principal activities are:

- To coordinate and encourage development of undergraduate/graduate courses on campus to constitute an interdisciplinary environmental management and policy concentration
- To develop and offer executive management programs and symposia focused on critical and emerging topics in environmental management and policy
- To stimulate development of new methods and management practices for achieving reductions in environmental risk





## admissions

### Undergraduate

Admission to the undergraduate school is managed by the Office of Undergraduate Admissions. Prospective students are encouraged to investigate the university by visiting the campus. Admissions staff are available to answer questions, arrange campus tours, provide additional information about degree programs and link visitors with appropriate campus offices and members of the university community.

#### Contact

Office of Undergraduate Admissions  
Vanderbilt University  
2305 West End Avenue  
Nashville, TN 37203-1727  
(615) 322-2561 or (800) 288-0432  
[admissions.vanderbilt.edu](http://admissions.vanderbilt.edu)

#### DATES TO REMEMBER

##### August

Common Application  
available at [commonapp.org](http://commonapp.org)

##### November 1

Application deadline for  
Early Decision I

##### November 5

Priority filing deadline for  
College Scholarship Service  
(CSS) PROFILE for Early  
Decision I

##### December 15

Early Decision I notification

##### January 1

Application deadline for  
Early Decision II and Regular  
Decision

##### January 5

Priority filing deadline for  
College Scholarship Service  
PROFILE for Early Decision II

##### February 3

Priority filing deadline for CSS  
Profile for Regular Decision

##### February 3

Priority filing deadline for  
FAFSA for Early Decision I,  
Early Decision II and Regular  
Decision

##### February 15

Early Decision II notification

##### April 1

Regular Decision notification

##### May 1

Deadline for matriculation  
deposit

### Graduate

To apply for admission to the graduate programs in civil and environmental engineering, you must first meet the general requirements of admission by the Vanderbilt University Graduate School. Application for admission may be made electronically through the Graduate School website at [vanderbilt.edu/gradschool](http://vanderbilt.edu/gradschool).

The Graduate School Catalog may be viewed at  
[vanderbilt.edu/catalogs](http://vanderbilt.edu/catalogs).

#### Contact

Engineering Graduate Programs  
ATTN: Civil and Environmental Engineering  
Vanderbilt University  
411 Kirkland Hall  
Nashville, TN 37240, U.S.A.  
Tel: (615) 343-2727  
[vanderbilt.edu/gradschool](http://vanderbilt.edu/gradschool)

#### DATES TO REMEMBER

##### October 22

Last date to take paper-based  
general GRE

##### November 19

Last date to take TOEFL  
(Internationals)

##### December 1

Last date to take computer-  
based general GRE

##### December 15

Application deadline, all  
supporting credentials for fall  
semester

##### February 15

Admissions offers made

##### April 15

Deadline to accept admission  
deposit



## financial aid

### Undergraduate

Vanderbilt is committed to enrolling talented, motivated students from diverse backgrounds. More than 60 percent of Vanderbilt students receive some type of aid. The university offers a full range of merit-based scholarships, need-based financial assistance and financing/payment options to families of all income levels. More information can be found at [vanderbilt.edu/financialaid](http://vanderbilt.edu/financialaid).

#### Opportunity Vanderbilt

Beginning in the fall of 2009, need-based financial aid packages for all undergraduate students no longer include need-based loans. This latest initiative does not involve the use of income bands or “cut-offs” to pre-determine levels of eligibility and applies to all undergraduate students with demonstrated financial need who are U.S. citizens or eligible non-citizens. The end result is that, in addition to a realistic academic year earnings expectation, all need-based aid packages now include scholarships and/or grants (gift assistance) in place of need-based loans that would have previously been offered to meet demonstrated need.

### Graduate

Graduate students in the Department of Civil and Environmental Engineering seeking the Ph.D. degree receive a competitive stipend, full-tuition scholarship award and health insurance. Typically, students are first supported on a Teaching Assistantship and then a Research Assistantship once a thesis adviser has been identified. Students on a Teaching Assistantship assist the faculty with undergraduate courses, typically by grading assignments and holding office hours. Opportunities to teach are available for those that wish to gain such experience. Both Teaching and Research Assistantships can be supplemented by any one of the following university fellowships, which are awarded through a competitive process to highly qualified applicants.

- **University Graduate Fellowships**  
\$10,000/year for up to five years
- **Provost’s Graduate Fellowships**  
\$10,000/year for up to five years
- **Harold Stirling Vanderbilt Graduate Scholarships**  
\$6,000/year for up to five years
- **School of Engineering IBM Fellowships**  
\$4,000/year for up to four years plus an award of  
\$1,000 for professional development
- **Pao Chung Chen Fellowship**  
\$4,000/year for one year
- **Peter G. Hoadley Graduate Award**  
\$4,000/year for one year
- **Carl E. Adams Jr. Graduate Award**  
\$4,000/year for one year

In order to be considered for these fellowships, an applicant’s file must be complete by January 15. Prospective applicants are also urged to apply for external fellowships or grants from national, international, industrial or foundation sources.



# faculty

## Mark Abkowitz

*Professor of Civil and Environmental Engineering  
Professor of Engineering Management*  
Enterprise risk management, infrastructure adaptation to extreme weather events, intelligent transportation systems, nuclear waste disposal



## Douglas Adams

*Distinguished Professor and Chair of Civil and Environmental Engineering*  
Nonlinear structural dynamics and vibrations, structural health monitoring/diagnostics and damage prognosis, noise and vibration control, applications in aerospace and automotive systems, applications in energy systems including wind turbines and batteries, applications in defense and security platforms



## P.K. Basu

*Professor of Civil and Environmental Engineering  
Director of Graduate Studies in Civil Engineering*  
Multiscale modeling, new cementitious materials, real-time infrastructure health monitoring, life extension of structures, blast and ballistic impact effects



## Alan Bowers

*Associate Professor of Civil and Environmental Engineering*  
Environmental chemistry, modeling of water and wastewater treatment processes, role of uncertainty in biological and physical/chemical reactions



## Curtis Byers

*Professor of the Practice of Civil and Environmental Engineering*  
Structural analytical modeling and design, foundation systems



## Janey Camp

*Research Assistant Professor of Civil and Environmental Engineering*  
Geographic information systems (GIS), risk management, environmental engineering, climate change adaptation, infrastructure management, STEM for K-12 education



## James Clarke

*Professor of the Practice of Civil and Environmental Engineering  
Director of Graduate Studies in Environmental Engineering*  
Chemical and nuclear waste management, human health and ecological risk assessment, sustainable approaches to the remediation of contaminated sites



## Ravindra Duddu

*Assistant Professor of Civil and Environmental Engineering*  
Computational solid mechanics, multiscale and multiphysics fracture mechanics, constitutive modeling, cohesive zone modeling of fatigue delamination



## Andrew Garrabrants

*Research Associate Professor of Civil and Environmental Engineering*  
Fate and transport, leaching test method development, environmental release assessment, beneficial reuse of waste materials



## Sanjiv Gokhale

*Professor of the Practice of Civil and Environmental Engineering  
Director of Graduate Program in Construction Management*  
Trenchless technology, infrastructure—water and wastewater, schedule and cost reduction for Capital EPC projects



## George Hornberger

*Distinguished University Professor  
Craig E. Philip Professor of Engineering  
Professor of Civil and Environmental Engineering  
Professor of Earth and Environmental Sciences*  
Human-natural system interactions, drought adaptation, catchment hydrology, transport of dissolved species in soils and streams

## David Kosson

*Cornelius Vanderbilt Professor of Engineering  
Professor of Civil and Environmental Engineering  
Professor of Chemical Engineering  
Professor of Earth and Environmental Sciences*  
Nuclear waste, environmental remediation, leaching assessment, energy production residuals, contaminant mass transfer (groundwater, soil, sediment, waste), cement materials durability

## Steven Krahn

*Professor of the Practice of Nuclear Environmental Engineering*  
Nuclear fuel cycle, risk assessment, the implementation of technology in nuclear fuel cycle facilities

## Eugene LeBoeuf

*Associate Professor of Civil and Environmental Engineering  
Director of Undergraduate Studies in Civil Engineering*  
Physicochemical processes of environmental systems, fate and transport of engineered nanomaterials in the environment, optimization of multireservoir hydropower system operations

## Sankaran Mahadevan

*John R. Murray Sr. Chair in Engineering  
Professor of Civil and Environmental Engineering  
Professor of Mechanical Engineering*  
Structural and mechanical systems reliability, materials durability, fatigue and fracture, structural health monitoring, modeling and data uncertainty, optimization under uncertainty, multidisciplinary systems



## Çağlar Oskay

*Assistant Professor of Civil and Environmental Engineering*  
Multiscale computational mechanics, life prediction, performance assessment, computational modeling of heterogeneous materials, modeling of multiphysics problems



## Charles Powers

*Professor of Environmental Engineering*  
How can technical assessments be framed to inform regulatory requirements to produce protective, cost-effective and sustainable environmental priorities and results?



## Florence Sanchez

*Associate Professor of Civil and Environmental Engineering*  
Performance and durability of cement-based composites, multiscale experimental characterization of materials, molecular dynamics modeling at interfaces, mass transport processes with chemical reactions in porous media



## Robert Stammer

*Associate Professor of Civil and Environmental Engineering*  
Traffic engineering, urban transportation planning, transportation design issues, highway safety, and accident reconstruction



## Lori Troxel

*Associate Professor of the Practice of Civil and Environmental Engineering*  
Concrete and steel design, sustainable infrastructure







department setting

Vanderbilt

Cornelius Vanderbilt had a vision of a place that would “contribute to strengthening the ties that should exist between all sections of our common country” when he gave a million dollars to create a university in 1873. Today, that vision has been realized in Vanderbilt, an internationally recognized research university in Nashville, Tenn., with strong partnerships among its 10 schools, neighboring institutions and the community.

Vanderbilt offers undergraduate programs in the liberal arts and sciences, engineering, music, education and human development, as well as a full range of graduate and professional degrees. The combination of cutting-edge research, liberal arts education, nationally recognized schools of law, business and divinity, the nation’s top ranked graduate school of education and a distinguished medical center creates an invigorating atmosphere where students tailor their education to meet their goals and researchers collaborate to address the complex questions affecting our health, culture and society.

An independent, privately supported university, Vanderbilt is the largest private employer in Middle Tennessee and the second largest private employer based in the state.

Nashville

Vanderbilt’s hometown of Nashville is a vibrant, engaging city known proudly as “Music City, U.S.A.” The university’s students, faculty, staff and visitors frequently cite Nashville as one of the perks of Vanderbilt, with its 330-acre campus located a little more than a mile from downtown.

From serving as home to the nation’s largest Kurdish population to being named America’s friendliest city for three years in a row, Nashville is a metropolitan place that exudes all of the charm and hospitality one expects from a Southern capital.

The city was settled in 1779 and permanently became state capital in 1843. The city proper is 533 square miles with a population of nearly 570,000. Major industries include tourism, printing and publishing, technology manufacturing, music production, higher education, finance, insurance, automobile production and health care management. Nashville has been named one of the 15 best U.S. cities for work and family by *Fortune* magazine, was ranked as the No. 1 most popular U.S. city for corporate relocations by *Expansion Management* magazine and was named by *Forbes* magazine as one of the 25 cities most likely to have the country’s highest job growth over the coming five years.



INSIGHT ◦ INNOVATION ◦ IMPACT®

The Vanderbilt University School of Engineering is internationally recognized for the quality of its research and scholarship. Engineering faculty and students share their expertise across multiple disciplines to address four specific research initiatives that characterize the school’s commitment to help solve real-world challenges with worldwide impact. They are health and medicine, energy and natural resources, security, and entertainment. All programs leading to the bachelor of engineering degree are accredited by the Engineering Accreditation Commission of ABET (abet.org).



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