

Critical Infrastructure Protection

The American and International Experience

17-25 August 2012, Norfolk, Virginia, USA

**A Continuing Education Academic Certificate for High Representatives
and Decision Makers of Institutions and Infrastructure Operators**

A Professional Development Academic Certificate in CIP

Advanced Course on Critical Infrastructure Protection (CIP)

Modern societies are highly dependent on the continuous operation of critical infrastructures that ensure the supply of essential goods and services. These include amongst others power supply, drinking water supply, information and communication technologies or waste disposal. Disruptions may have rapid repercussions for the population and the basis of its livelihood, and can affect other critical infrastructures through domino effects. A power blackout will also disrupt the water supply, telecommunications, and rail transport. Today's critical infrastructures are large-scale sociotechnical systems, comprised of multiple components, involving various stakeholders, technologies, policies and social factors. In recent years, numerous sociotechnical systems have started to undergo a series of transitions, with direct consequences on the nature of the criticality of the infrastructures, the threats to which they are subject, and the effective means for protecting them. These are long-term fundamental changes (irreversible, high impact and of high-magnitude) in the cultures (mental maps, perceptions), structures (institutions, infrastructures and markets), and practices (use of resources) of a societal system. In other words, the transition includes a structural change in both technical and social subsystems.

The planning and implementation phases of such large-scale infrastructure transitions require close monitoring of performance parameters like safety, efficiency, and sustainability. Ensuring that infrastructure evolution reveals a safer and more sustainable system becomes a major challenge for society at large, for governments, for the operators of the utilities, and for the other industrial systems that depend upon those infrastructures. There-

fore, it is vital to maintain the operability of the critical infrastructures while enabling an evolution that is sustainable within the context of the security concerns generated by our increasing dependences. The ultimate goals are ensuring quality of life and business continuity in the most adverse conditions. Moreover, further and even more accelerated changes can be expected in the near future.

Critical Infrastructure Protection provides a comprehensive framework for managing the key infrastructures, assets and resources on which we depend at local, national, regional and global levels. Various actors, mostly governmental, have pursued an independent development of this field, generating solutions of a technical, organizational and strategic nature. Great advances can be made through cooperation and experience-sharing, bringing together these isolated developments and constructing a comprehensive image of the complexities involved. Rapid development of the sector has enhanced our understanding of the depth to which critical infrastructures are interconnected and, therefore, the potential dangers that disruptions (intentional or unintentional, natural or man-made, sudden or gradual) in a single area pose to the entire system-of-systems emerging in modern societies:

1. CIP is based on risk analyses that take into account a comprehensive threat spectrum.
2. Measures include all aspects of integral risk management.
3. Operators, Local and National Authorities are responsible for the protection (subsidiarity).
4. Proportionality must be maintained in designing protection measures.
5. Protection measures aim at strengthening resilience.



At the same time, the experience of the last years demonstrates the limitations and shortcomings of different measures. There are differences in interests and concerns between governments and utilities, while protecting infrastructures require investments and actions across sectors. That demand extended coordination and the sharing of sensitive information, and the level and urgency of threat might not be uniformly perceived among the different stakeholders.

This course aims to give decision makers from institutions and critical infrastructure operators an overview of the existing complexities of Critical Infrastructure Protection, as well as an introduction into the changing landscape of infrastructures, highlighting new tools and methods, as well as new vulnerabilities and risks. At the end, participants will have a clearer picture of the evolving security landscape and the culture which must be developed to meet its requirements. During the course, renowned scientists, experts in their fields, will give lectures on different but, ultimately, complementary areas of CIP, and will work towards enhancing the participants' competences in the following four areas:

1. *Prioritizing critical infrastructures*, in order to use scarce resources more efficiently, and enabling the maintenance of a "CIP inventory" which evolves continuously with the needs of the stakeholders.

2. *Protection through comprehensive approaches*, by analyzing the risk spectrum, performing assessments and risk governance, planning for contingencies, as well as running scenarios for training and command purposes. Research and development provide new tools for enhancing the performance of security efforts, as well as analyzing these processes and enabling incremental improvements to standards and practices.

3. *Establishing foundations in a number of areas*, such as cascading effects in case of disruptions and mutual dependences, which are often overlooked because of a narrow focus by individuals and organizations on the meaning of critical infrastructures and their scope.

4. *Fostering risk communication and governance* – promoting awareness among stakeholders of the potential repercussions of a systemic risk materializing, sensitizing them to various risks and threats and disseminating knowledge of the best practices against them.

The course is endorsed by:

- Old Dominion University - Business Gateway, Norfolk, VA
- Virginia Center for Modeling, Analysis and Simulation – Norfolk, VA
- Center for Understanding Change - USA
- National Centers for Systems of Systems Engineering, ODU – Norfolk, VA

Specialists

Adrian Gheorghe

Dr. Gheorghe is a world renowned scientist and a pioneer in the field of Critical Infrastructure Protection (CIP). In his capacity as leading authority on CIP, he is involved in or leads international projects in Asia, the Middle East, Europe and the United States. He holds a M.Sc. Electrical Engineering, Faculty of Power Engineering, Bucharest Polytechnic University (1968), Romania. He has a Ph.D. in Systems Science/Systems Engineering, from City University, London (1975); an MBA from the Academy of Economic Studies, Bucharest (1985); M.Sc. in Engineering-Economics, Bucharest Polytechnic University. Previously he was involved in educational activities as Professor of Industrial/Energy Policy and Organizational Management, Bucharest Polytechnic University, Romania, Department of Physics, University of Bucharest, and Professor for Industrial Risks and Decision Analysis, Faculty of Chemical Engineering, Bucharest Polytechnic University, Romania. He was a civil servant (1990-1993) with the International Atomic Energy Agency, Vienna, Austria working in the field of comparative risk assessment of various energy systems, and regional risk assessment of nuclear and industrial systems. During 1993 - 2006 he was Director with the Centre of Excellence on Risk and Safety Sciences, and Senior Scientist, with the Swiss Federal Institute of Technology, Zurich, Switzerland and Professor (Visitor) Operations Research and Decision Analysis. In March

2006 he was appointed as Professor of Engineering Management and Systems Engineering, and offered the Batten Endowed Chair on System Engineering. He is also a Professor of Engineering Economics at the Polytechnic University of Bucharest. His research interests are in the fields of risk and vulnerability assessment for complex systems, systems engineering modeling for critical infrastructures (e.g. energy systems, multimodal transportation infrastructures, IT security, and petrochemical and refineries complexes), system of systems engineering, emergency planning and preparedness, Decision Support Systems and stakeholders interactions, smart grids, the emerging field of serious gaming and energy infrastructures policy.

Charles B. Daniels

Dr. Daniels has over 40 years of experience in organizational management and leadership, communications systems, information systems, management consulting, change management, employee and leadership development and quality improvement in both government and commercial enterprises. He has over 30 years of experience in program management for large scale, mission-critical systems; system development life-cycle analysis; planning and implementation; systems engineering; line management and engineering; culture change and management consulting. He has also served as a senior executive and Vice President for En-

gineering for a Fortune 500 commercial enterprise with several major Defense and Aerospace Companies and has managed large, complex technical enterprises with over 600 employees and over \$100 million in annual revenues. He has supported NASA Human Space Flight, Science and Aeronautics Research programs for over 25 years at the Goddard Space Flight Center, the Johnson Space Center, the Langley Research Center, the Ames Research Center, the Marshall Space Flight Center and the Jet Propulsion Lab. Dr. Daniels also played a key role as a contractor executive in the design, development and implementation of several U.S. national criminal justice information systems implemented by the U.S. Federal Bureau of Investigation (FBI), including the Automated Integrated Fingerprint Identification System (AFIS). Dr. Daniels is the founder of the ConITS Leadership Institute. In addition, Dr. Daniels has been a lecturer in the George Washington University Engineering Management and Systems Engineering Graduate Program, and the Florida Institute of Technology Graduate Engineering Management programs and the California Institute of Technology at Irvine. Dr. Daniels is currently a member of the faculty of the Engineering Management and Systems Engineering Department of the Batten College of Engineering and Technology at the Old Dominion University in Norfolk, Virginia.

Kara Norman Hill

Dr. Kara Norman Hill is an associate with Booz Allen Hamilton where she has consulted for the Department of Defense and the Department of Homeland Security. She recently graduated with her doctorate from Old Dominion University. Her research was focused on risk analysis and risk perception as they pertain to homeland security, homeland defense, infrastructure protection, and emergency preparedness, response, and recovery. She has recently participated in a project for the Department of Homeland Security which assessed the vulnerability of critical infrastructures, key assets and resources, through the use of advanced data systems. Kara's other areas of expertise include statistics, engineering management, and operations research.

Ersin Ancel

Dr. Ersin Ancel received his BS from Istanbul Technical University, Turkey and MS from Old Dominion University, Norfolk, VA in Aerospace Engineering in 2005 and 2007, respectively. He received his Ph.D. from Old Dominion University in Engineering Management and Systems Engineering in 2011. He is currently working as a Research Engineer in aviation safety at National Institute of Aerospace (NIA) as a NASA contractor. His research focuses on modeling of complex socio-technical systems while understanding and demonstrating the interaction of organizational factors with technical architectures. He is in charge of developing aviation accident models within the National Airspace System (NAS) and evaluating the effects of various NASA technologies over the implementation of Next Generation Air Transporta-

tion System (NextGen). His past experiences include probabilistic safety assessment (PSA) applications in Surry Nuclear Power Plant as well as developing serious gaming solutions involving the NAS.

Berna Tokgoz

Mrs. Berna Tokgoz is a doctoral student at Old Dominion University, the Department of Engineering Management and Systems Engineering, pursuing research into the probabilistic analysis and the quantification of the resilience of infrastructures faced with extreme natural hazards, particularly hurricanes and storms. She is also an assistant professor within the Department and has worked on projects relating to the resilience of regional critical infrastructures, financed by the Department of Homeland Security. Her published articles concern mainly the resilience of infrastructure systems when faced with natural disasters.

Marcelo Masera

Marcelo Masera is a Scientific Officer of the European Commission, working at the Joint Research Centre (JRC), Petten, in the Netherlands. He is currently the leader of the Energy Security Group, with the mission of supporting European policies in this field, and promoting transatlantic cooperation. Working on energy security enables him to study a cross section of critical infrastructures in society, touching on subjects such as cyber-security, infranomics, etc. Among other activities, he manages the labs on Internet resilience and industrial networking security, together with the initiative aimed at creating a European Reference Network for Critical Infrastructure Protection. He joined the European Commission in November 2000. His background is in electronics and electrical engineering, and has more than 25 years of professional experience in the fields of risk, safety and security. His research interests include security of networked systems and systems-of-systems, risk governance of infrastructures, security of industrial control and communication systems, and assurance cases for security.

Adolf Dörig

Mr. Dörig has over twenty years of experience in the consulting and risk management fields, advising clients on information system reengineering and risk management in the financial services, high-tech, pharmaceutical and telecommunications industries. Beginning his career at Zurich Financial Services as Head of "Resort Systems Engineering" leading 15 engineers, his other positions included Partner at both Price Waterhouse and Arthur Andersen and Senior Partner at Ernst & Young. During his tenure at Price Waterhouse and Arthur Andersen, Mr. Dörig was responsible for successfully developing and building up several new expert units dealing with risk management. Prior to his responsibility as the Managing Partner of Pukall Doerig + Partner Mr. Dörig was a Deloitte Partner responsible for Enterprise

Risk Services in Switzerland. Mr. Dörig is a frequent speaker at Business, ICT and Risk Management events. He graduated with a B.S. in mechanical engineering at the University of Applied Sciences, Rapperswil, Switzerland and completed post graduate studies in systems engineering.

Barry Ezell

Dr. Barry Ezell is a retired Army officer and combat veteran with 20 years of experience in military decision making, operations research and risk analysis in the Department of Defense and the Department of Homeland Security, with special emphasis on critical infrastructure protection, Supervisory Control Data Acquisition (SCADA), systems and weapons of mass destruction, terrorism risk assessments for Chemical, Biological, Radiological, and Nuclear events. His most recent projects are as the principal investigator for Virginia's Office of Veterans Affairs & Homeland Security's Hampton Roads Full Scale Exercise and project manager for DHS Office of Risk Management and Analysis' Methodological Enhancements to the Risk Assessment Process for Informed Decision Making (RAPID). Ongoing applied research and analytic work combines advanced concepts in adversary modeling for the Science and Technology Directorate of the DHS and in developing risk models to inform programmatic decisions at the federal and regional levels of government. He is a member of Hampton Roads Urban Areas Working Group and the Hampton Roads Critical Infrastructure Key Resources Steering Group. He has authored 30+ papers and currently serves as associate editor for Military Operations Research, editor board member for the International Journal of Critical Infrastructures Systems and the publication Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science. He is a member of the Society for Risk Analysis, Military Operations Research Society, Institute for Operations Research and the Management Sciences, and Association of the United States Army. Dr. Ezell is the recipient of Society for Risk Analy-

sis' Best Paper in a Series, 2010 and recipient of the Distinguished Graduate Award from the Center for Risk Management of Engineering Systems, University of Virginia, 1998. His areas of expertise include: all-hazards risk and decision analysis, operations research systems analysis, probabilistic risk assessment, capabilities-based assessment, insurgency and terrorism. He is a Research Professor with the VMASC (Virginia Modeling and Simulation Center), Old Dominion University in Norfolk, Virginia.

Bradley Holtz

A well-recognized analyst and trusted voice in engineering software today, Bradley Holtz has incisive views on computer-aided design (CAD) and related applications, which are based on a keen understanding of new technologies and years of careful observation of their impact on design, engineering, architecture, and manufacturing. His insights have made him a highly-valued adviser to the financial world and to industry executives. In addition to the investment and legal communities, his customers have included manufacturers in diverse fields, such as aeronautics and electronics. He is a leading proponent of educating top user management about the value of investing in engineering software. As CEO of Cyon Research Corporation, Mr. Holtz was the driving force in developing COFES: The Congress on The Future of Engineering Software, which has become the leading event of its kind. A registered architect, Bradley Holtz has served as chairman of The CAD Society, is on the board of directors of The CAD Management Institute and has followed the CAD industry since its inception. He is also a member of the Computer Graphics Pioneers. His influential opinions about the future of software have appeared in all the major engineering software industry publications, and he has been a featured speaker at industry events on four continents. Mr. Holtz has a B.A. in biology from Washington University (St. Louis) and a B.Arch. from the University of Maryland.

Breakdown of Presentations

Adrian Gheorghe

"Next Generation Infrastructure – 21st Century Reality"

In order to improve quality of life and business continuity, the development of new critical infrastructures must be based on the existing infrastructure architecture, both as a launching point and as a solid foundation. It is not desirable to achieve complete separation of the old and the new layers of infrastructures, since security gains in one area will be heavily offset by magnified and multiplied vulnerabilities in another. Harmoniously integrating the two will require a new approach, based on organic growth of the existing

stock of infrastructures. The lecture will touch on specific issues relating to the interdependences between different types of infrastructures, the assessment of their level of complexity and the governance of critical infrastructure risks at national, European and international levels. A number of agent-based and object-based models will be introduced to highlight issues regarding business continuity and regulation compliance. In the future, as the "forest of regulations" grows thicker, the cost of non-compliance, both at technical, financial and legal levels becomes even greater. At the same time, non-compliance becomes more probable with every new level of complexity achieved by the regulatory environment.

Charles B. Daniels
“Ethics and Leadership in the Time of Complexity”

This three-hour discussion will examine the influence and relationship of leadership on organizational culture and will seek to create awareness of the warning signs and hazards of a culture that is or may become problematic. In addition, the discussion will seek to create awareness of some of the underlying characteristics of human perception that often lead to actions, behaviors and decisions that may propagate unintended consequences in terms of risk, governance and organizational viability.

Kara Norman
“Risk Evaluation for Critical Infrastructure and Key Assets: The Advent of Risk Perception”

Risk to an asset, such as a critical infrastructure, is often considered to be a function of threat, vulnerability, and consequence. However, risk is also a function of our perceptions and those perceptions can influence our understanding of threat, vulnerability, and consequence. A risk quadruplet methodology is proposed to systematically integrate risk perceptions with assessments of threat, vulnerability, and consequence in a traceable, reproducible, and meaningful manner. Finally, the viability of the risk quadruplet model is explored by leveraging Evidential Reasoning, a Multi Criteria Decision Analysis technique, along with simulated data for threat, vulnerability, consequence, and perception. At the end of the lecture, participants will have been presented with a new mathematical model for risk assessment and prioritizing strategic management for CIP, key assets and key resources. This model simultaneously takes into account quantitative elements along with qualitative elements such as the risk perception of stakeholders.

Ersin Ancel
“Serious Gaming as a Tool for Assessing Risks for Future Infrastructure Systems”

The successful implementation of the next generation infrastructure systems requires solid understanding of their technical, social, political and economic aspects along with their interactions. The lack of historical data that relate to the long-term planning of complex systems introduces unique challenges for decision makers and involved stakeholders which in turn result in unsustainable systems. Also, the need to understand the infrastructure at the societal level and capture the interaction between multiple stakeholders becomes important. The use of gaming and simulation techniques as a formal approach to strategy making has gained wide acceptance. Gaming methods (or soft systems thinking) have become an alternative to formal complexity modeling techniques like systems dynamics and operations research. These techniques have been successfully applied to well-structured problems. They

are able to provide decision makers with an environment in which the totality of the system and its dynamics are present. With a holistic approach that includes the wide-range of perspectives, skills, information, and mental models of the involved parties, the quality of the decision-making environment increases dramatically. Unlike hard-system methods, the gaming and simulation approach is quite flexible and easily adaptable to other quantitative methods, scenarios, and computer models. Policy gaming methods can help both participants and modelers understand the big picture and identify critical elements of the complex problem at hand. Because of the iterative and experimental nature of these gaming and simulation environments, participants are able to test different approaches within both a safe environment and a condensed timeframe.

Berna Tokgoz
“Resilience Engineering: The Impact of Natural Hazards on Critical Infrastructures”

Today, natural or man-made disasters are both unpredictable and unavoidable. At the same time, their frequency of occurrence and the damages they can inflict are increasing quickly. As part of the general effort towards reducing the negative consequences arising from such events, the concept of resilience has gained a new stature in the field of emergency and crisis situation management. The lecture will focus on assessing a metric of community resilience when exposed to extreme natural phenomena, such as hurricanes and high winds. This resilience refers both to traditional, technical infrastructures, as well as key components of the emergency management system, such as fire stations and police stations.

Marcelo Masera
“The European Union Perspective on Infrastructure in the 21st Century”

This lecture aims to highlight the particularities of the European approach to Critical Infrastructure Protection. Rather than having a single, unifying vision, Europe has a veritable ecosystem of competing and complementing policies, usually at the national level. In the case of the European Union, the Commission attempted to harmonize the different philosophies, beginning with a green paper in the year 2000, entitled “Towards a European Strategy for the Security of Energy Supply”. As infrastructures become more and more European, national strategies become inadequate for the provision of security. Even now, most progress that has been made in a field as critical and as poorly understood as energy security has concentrated on ensuring supply from the point of origin. The lecture will highlight the complexities inherent in discussing European, as opposed to EU, strategy and will use references to Europe and EU member states. Finally, the impact of shale gas and smart grids on an enlarged security concept will be analyzed.

Marcelo Masera & Adolf Dörig

“Comparative Evaluation of Critical Infrastructure Protection Approach – Views from the United States and European Union – Switzerland”

While European and American examples might be better known, Switzerland provides a model for a thorough focus on Critical Infrastructure Protection on the part of government authorities. In Switzerland, ten sectors such as energy, transport, or financial services are considered critical at the national level. They can be further categorized into 28 sub-sectors, such as power, oil, and gas supply within the energy sector. Advanced protection measures are already in place for some individual sub-sectors and in particular for the installations they contain (such as substations, control centers for grid management, and transformer stations). However, for a long time, cross-sector coordination and a consolidated approach at the national level were lacking. In June 2005, therefore, the Swiss Federal Council mandated the Federal Office of Civil Protection (FOCP) to coordinate efforts in the area of Critical Infrastructure Protection (CIP) and to establish a CIP Working Group in which all relevant authorities were represented. Milestones were set for 2007, 2009 and 2011, each marking an enhancement of Swiss strategic capabilities in the area of resilience and emergency management. Their Basic CIP Strategy was enhanced, by 2011, into a National CIP Strategy, which stressed the importance of information sharing between stakeholders, such as Federal authorities, the Cantons and the Operators, as well as the optimization of CIP processes and the prioritization of certain key infrastructures. There is even a CIP support group as a strategic consultation and advisory body involving representatives of the public sector, the corporate sector, and the Cantons.

Barry Ezell

“Modeling and Simulation as Resources for Risk Governance Performance: Regional and National Dimension”

Based on the combined military and civilian experience of the lecturer, this presentation will highlight the advanced uses of modeling and simulation capabilities in the decision making process, by opening up previously unrecognized and unexplored avenues of response. The use of new methods, models and visualization techniques transforms modeling and simulation into an actual resource for critical infrastructure protection, no less important than money. Issues of risk, resilience and governance can, therefore, be better managed at regional and national level.

Adrian Gheorghe & Bradley Holtz

“Understanding Change for Next Generation Infrastructure Security Governance”

Neither authorities, nor industrial or academic bodies can afford to ignore the convolution of opportunities and risks accompanying the implementation of the new generation of infrastructures. The shape of our society will be determined by the characteristics of, and the services delivered through, those infrastructures. In this picture, communications, mobility, commerce, energy, health, finance, education, environmental impact, security, and up to international relations, each and all of them cannot be treated independently. This lecture aims to impress upon the participants the importance of understanding the complexities of modern infrastructure systems, in order to track the effects that a change, no matter how small, will have on the entire system-of-systems. The effects are even more dramatic in the case of negative events, and the security governance of future infrastructure systems is dependent on the ability of stakeholders to chart the infrastructure topography before a shock exposes and exploits a weakness in the entire edifice.



Chrysler Museum Of Art, Norfolk, Virginia

Proposed Schedule

Friday 17.08.2012

- Departure from Otopeni International Airport at 06:25; Arrival at Norfolk International Airport at 18:25 and journey to Marriott Hotel on ODU Campus

Saturday 18.08.2012

- Registration and check-in, tour of campus, other administrative activities

Sunday 19.08.2012

- Visit to Norfolk Naval Base facilities

Monday 20.08.2012

- Lecture 1 (3 hrs) – Adrian Gheorghe – *“Next generation Infrastructure – 21st Century Reality”*
- Lecture 2 (3 hrs) – Charles B. Daniels – *“Ethics and Leadership in the Time of Complexity”*

Tuesday 21.08.2012

- Lecture 3 (3 hrs) – Kara Norman Hill – *“Risk Evaluation for Critical Infrastructure and Key Assets: The Advent of Risk Perception”*
- Lecture 4 (3 hrs) – Ersin Ancel – *“Serious Gaming as a Tool for Assessing Risks for Future Infrastructure Systems”*

Wednesday 22.08.2012

- Lecture 5 (3 hrs) – Berna Tokgoz – *“Resilience Engineering: The Impact of Natural Hazards on Critical Infrastructures”*
- Lecture 6 (1.5 hrs) – Marcelo Masera – *“The European Union Perspective on Infrastructure in the 21st Century”*
- Lecture 7 (1.5 hrs) – Marcelo Masera & Adolf Dörig – *“Comparative Evaluation of Critical Infrastructure Protection Approach – Views from the United States and European Union – Switzerland”*

Thursday 23.08.2012

- Lecture 8 (3 hrs) – Barry Ezell – *“Modeling and Simulation as Resources for Risk Governance Performance: Regional and National Dimension”*
- Lecture 9 (3 hrs) – Adrian Gheorghe & Bradley Holtz – *“Understanding Change for Next Generation Infrastructure Security Governance”*

Friday 24.08.2012

- Fieldtrip 1 – *The Virginia Modeling, Analysis and Simulation Center (VMASC)*
- Fieldtrip 2 – *ODU Research Labs tour*
- Final discussions

Saturday 25.08.2012

- Departure from Norfolk International Airport at 17:03 and arrival at Otopeni International Airport at 17:40 on Sunday, 26.08.2012

About Old Dominion University, Norfolk, Virginia, USA

Innovation

...In Teaching

Learning the modern way - the ODU way - isn't one-dimensional. It sparks your imagination, taps all of your senses, and makes use of today's technologies. ODU professors bring classrooms to life. They are the recipients of 25 Virginia Outstanding Faculty Awards, the highest honor for teaching in the state, and numerous other teaching recognitions. Nearly 95% of ODU classrooms and modern buildings are packed with 21st century teaching technology. From the award-winning, and, learning happens in and out of ODU classrooms. One thing is for certain: learning at ODU will prepare you to succeed anywhere.

...In Scholarship

ODU professors are masters in their fields, recognized by peers, organizations, businesses, and industries across the country.

...In Research

Old Dominion University research teams generate \$88 million in annual funding through more than 400 ongoing projects. Supported by grants from National Science Foundation, National Institute of Health, Department of Education, Department of Energy, Department of Defense, they have already made groundbreaking advances in five major areas, with more to come:

- Modeling & Simulation
- Bioelectrics
- Maritime Health & Systems
- Alternative Energies
- Nanotechnologies

Mission of the University

Old Dominion University, located in the City of Norfolk in the metropolitan Hampton Roads region of coastal Virginia, is a dynamic public research institution that serves its students and enriches the Commonwealth of Virginia, the nation and the world through rigorous academic programs, strategic partnerships, and active civic engagement.

Old Dominion University was founded as the Norfolk Division of the College of William and Mary in 1930, became an independent institution in 1962 and now offers degrees in 68 undergraduate and 95 (60 masters/35 doctoral) graduate degree programs.

Background

Old Dominion University is located in Hampton Roads, one of the world's major seaports. Since the early seventeenth century, Hampton Roads has been the state's gateway to the rest of the world and the world's

gateway to Virginia in commerce and industry, in recreation and culture, and in national security. Now a complex of seven major cities, it is a microcosm of the opportunities and challenges of contemporary urban America. It is also a major center for research and development and a home for extensive scientific and technological activities in marine science, aerospace, ship design and construction, advanced electronics, and nuclear physics.

The University takes its unique character from Hampton Roads as it provides leadership to the state and nation in teaching, research, and service. Thus the University has a special mission for the Commonwealth in commerce, and in international affairs and cultures. It has a significant commitment in science, engineering and technology, particularly in fields of major importance

to the region. As a metropolitan institution, the University places particular emphasis upon urban issues, including education and health care, and upon fine and performing arts.

As one of America's major ports, Hampton Roads is the locus of national and international military commands, and the home of a culturally diverse population. The University therefore has natural strengths in activities having international outreach. Faculty members in such fields as business, economics, international studies, geography and the sciences strive to design curricula, teach courses, and encourage foreign exchanges that enhance the University's role as Virginia's international institution.

The Hampton Roads scientific environment provides special opportunities for science and engineering faculty to emphasize research and graduate programs in such fields as marine science, aerospace, and advanced electronics. Global ocean studies and cooperative research at NASA receive particular attention, as University researchers collaborate with U.S. and foreign engineers and scientists.

Mission Support

As a national leader in the field of technology-delivered distance learning, the University strives to enhance the quality of the educational experience, wherever education is delivered, by applying emerging technologies; it also supports research to explore the impact of these technologies on the teaching-learning process. By utilizing these technologies and by partnering with institutions of higher education, corporations, and governmental entities, the University is able to provide undergraduate and graduate degree programs to students across time and geographic boundaries.

The University is committed to providing the highest quality instruction to all of its students. Teaching excel-



lence is encouraged through faculty development programs and appropriate recognition of superior instruction.

The University encourages the involvement of its faculty and staff in community service. The enrichment of the lives of students and residents of Hampton Roads is fostered through university sponsored cultural activities,

fine and performing arts events, and intercollegiate athletics. In addition, through applied research, consulting, and other activities, the University plays a prominent role in the development of local business and industry and serves as a resource to government agencies and both public and private educational institutions.

Norfolk, Virginia, USA

Norfolk is an independent city in the Commonwealth of Virginia in the United States. With a population of 242,803 as of the 2010 Census, it is Virginia's second-largest city behind neighboring Virginia Beach.

Norfolk is located at the core of the Hampton Roads metropolitan area, named for the large natural harbor of the same name located at the mouth of Chesapeake Bay. It is one of nine cities and seven counties that constitute the Hampton Roads metro area, officially known as the Virginia Beach-Norfolk-Newport News, VA-NC MSA. The city is bordered to the west by the Elizabeth River and to the north by the Chesapeake Bay. It also shares land borders with the independent cities of Chesapeake to its south and Virginia Beach to its east. One of the oldest of the cities in Hampton Roads, Norfolk is considered to be the historic, urban, financial, and cultural center of the region.

The city has a long history as a strategic military and transportation point. Norfolk Naval Base is the world's largest naval base, and the world's largest military alliance, the North Atlantic Treaty Organization (NATO) has its defense headquarters here. The city also hosts the corporate headquarters of Norfolk Southern Railway, one of North America's principal Class I railroads, and Maersk Line, Limited, who manages the world's largest fleet of US-flag vessels.

Norfolk is linked to its neighbors by an extensive network of Interstate highways, bridges, tunnels, and bridge-tunnel complexes. Through its extensive port facilities, the second largest on the East Coast of the United States after the Port of New York, pass 50 million tons of coal each year, along with two million shipping containers.



Downtown Norfolk (labels)

The National Centers for System of Systems Engineering

The National Centers for Systems of Systems Engineering (NCSOSE) is an organization composed of a network of Enterprise Research Centers located in six of the most prestigious universities in the United States, including Old Dominion University. The one in the Batten College of Engineering and Technology at Old Dominion University focuses on complex systems problems. The Center develops and tests theory, methods, technologies, tools, and provides focused training to more effectively deal with complex system problem domains. NCSOSE's primary goals are to advance the body of knowledge and state-of-the practice relating to engineering complex systems of systems.



*National Centers for System of Systems Engineering 4111
Monarch Way Suite 406 Norfolk VA 23508-2563 USA*

As an enterprise research center, NCSOSE seeks to draw together academia, government, and industrial organizations to resolve problems, develop technologies, and direct research concerning major issues in the design, analysis, and integration of complex systems of systems. NCSOSE was born out of a recognized need to effectively develop, coordinate, and integrate research and applications to engineer increasingly complex systems that must function as integrated systems of systems. NCSOSE supports the development of practical solutions and directs applied research that addresses contemporary system of systems engineering problems; provides high-quality information resources for those who make decisions, influence policy, and are charged with integration of complex systems of systems; and provides training and education in systems of systems engineering. NCSOSE frequently works in partnership with other research organizations and higher education institutions to enhance the quality of research in systems of systems engineering by promoting the interchange of academic research and knowledge.

Main Research Areas at NCSOSE

Complex System Governance

There is much to be gained by establishing a holistic paradigm for Complex System Governance quite distinct from those previously observed. There are many deep reaching questions that exploration of System Governance functions can offer mission-oriented organizations or entities. In particular, paradigm development can help to understand the methods, technologies, and tools that might be necessary to enhance performance in the different functions that have been preliminarily identified. In one sense, this becomes a manifestation of introspective self-referential research undertaken on behalf of sponsors for their internal mechanisms as well as the wider externalities of the enterprise.

Research & Training for Next Generation SoS Engineers

NCSOSE takes a lead role in the definition of education and training necessary to propagate System of Systems Engineering to the engineering community of practice. Using an in-house developed proprietary SoSE methodology, NCSOSE training and development programs are heavily grounded on the rigorous engineering methods for understanding and framing complex problems. In so doing, the risk that the early parts of the study will contain a significant error that impacts the efficacy of the developed solutions will be minimized.



The Virginia Modeling, Analysis and Simulation Center

The Virginia Modeling, Analysis and Simulation Center (VMASC) is a university-wide multidisciplinary research center that emphasizes modeling, simulation, and visualization (MS&V) research, development and education. The mission of the Center is to conduct collaborative MS&V research and development, provide expertise to government agencies and industry, and to promote Old Dominion University, Hampton Roads and Virginia as a center of MS&V activities.



VMASC is one of the world's leading research centers for computer modeling, simulation, and visualization. Working with more than one hundred industry, government, and academic members, VMASC furthers the development and applications of modeling, simulation and visualization as enterprise decision-making tools to promote economic, business, and academic development. Annually, the Center conducts approximately \$10M in funded research.

Old Dominion University is a state-assisted institution and one of only four Virginia schools in the Carnegie Research Universities (high research activity) category. The University offers a complete range of Modeling & Simulation degree options from Bachelor's to Ph.D.

The Hampton Roads region is home to the Joint Coalition Training Center, the US Army's Training and Doctrine Command, the Military Transportation Management Command, NATO Allied Command Transformation, the Armed Forces Staff College, the U.S. Navy's Commander Operational Test and Evaluation Force, the Naval Sea Systems Command, and the Space and Naval Warfare Center. In addition, the Department of Energy's Jefferson Lab, NASA-Langley Research Center and numerous regional industries are important users of MS&V technology. The economic value of MS&V-related business activity in Hampton Roads is estimated to be over \$500M.

Research

"VMASC's mission and goal is to provide valuable skills and technology to address complex problems and to assist difficult decision-making. The Center strives to foster a strong collaborative relationship among academia, industry, and government partners to succeed in our research. New research and technical support awards totaled nearly \$9.6 million last year alone. M&S has been designated as a "national critical technology", solidifying the fact that it is vital to both our national security and to the United States' position in the global market. Efforts are underway to have M&S formally recognized as its own industry, a move that will solidify its place in the economy. M&S is

clearly emerging as its own academic discipline with several universities offering graduate degrees, with ODU once again leading the way."

- VMASC Executive Director Dr. John A. Sokolowski

VMASC researchers analyze and apply modeling and simulation to unexplored problems and real-time challenges in unique and established domains. The Center's expertise lies in both pure and applied research, highlighted by a unique multidisciplinary M&S approach in eight-core modeling and simulation applied research areas:

- Transportation
- Homeland Security and Military Defense
- Virtual Environments
- Social Sciences
- Medicine & Health Care
- Game-based Learning
- M&S Interoperability
- System Sciences

Personnel

VMASC's accomplished faculty members work in varied fields of expertise to successfully expand on and bring unique innovations to modeling and simulation research and development.

Its staff consists of approximately 50 people including research faculty, project scientists, support personnel for technology, program & budget management, institutional advancement, and embedded technical expertise as well as affiliated M&S faculty from Old Dominion University's main campus.





EURISC FOUNDATION

S I N C E 1 9 9 5

Eurisc Foundation
European Institute for Risk, Security and Communication Management

The EURISC Foundation is an independent Think Tank, set up in Bucharest, Romania in 1995 to study and promote issues related to risk, security and communication. The EURISC Foundation seeks to promote security research and innovation (energy security, critical infrastructure protection and others), dialogue, education, training and research on major issues of national and international security. These include nonproliferation, non-military risks, primarily natural hazards, climate chaos and national security, emerging systemic risks, corruption, organized crime (including illegal emigration and trafficking), terrorism, the security sector reform, security sector governance and the security culture. It is at the forefront of research in the fields of Energy Security, Critical Infrastructure Protection and Security Sector Reform. Its staff consists of the right mix of senior, retired members of the military, the Diplomatic Corps and academia, and junior researchers in the process of acquiring their PhD.

EURISC Foundation:

- European Institute for Risk, Security and Communication Management
- Romanian Institute for International Studies (IRSI)

Areas of interest:

Critical infrastructure protection, energy security, security sector reform, crisis situation management, security and defense, foreign policy and diplomacy, political issues, information and communication, good energy governance, law enforcement and national security, risk management, vulnerabilities and good governance, public relations, science and technology, stakeholder's participation, security culture.

The EURISC Foundation has extensive partnership with ministries, public institutions, academia and NGOs from Romania and abroad in the area of research, consultancy services and other forms of cooperation.



The Center for Understanding Change