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Editorial

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C. Ariel Pinto joined the Department of Engineering Management and Systems Engineering at Old Dominion University in 2004. He earned his Doctorate degree in Systems Engineering from the University of Virginia (2002) and Master and Bachelor in Industrial Engineering from the University of the Philippines. In 2009, he co-founded the Emergent Risk Initiative @ ODU with the mission to create next generation body of knowledge in risk management. He is the outgoing Chair of the engineering and infrastructure specialty group for the Society for Risk Analysis and is a board member for the Hampton Roads chapter of INCOSE.

Adrian V. Gheorghe obtained his MSc in Electrical Engineering from the Faculty of Power Engineering of the Bucharest Polytechnic Institute in 1968, his PhD in Systems Science/Systems Engineering from the City University, London, in 1975, his MBA degree from the Academy of Economic Studies, Bucharest, in 1985 and his MSc in Engineering Economics from the Bucharest Polytechnic Institute. For many years, he has held a permanent position with the International Atomic Energy Agency in Vienna and was a Senior Scientist with the Swiss Federal Institute of Technology in Zurich, Switzerland. Currently, he holds the Batten Endowed Chair on Systems Engineering with the Old Dominion University in Norfolk, Virginia, USA.

This special issue of the *International Journal of Critical Infrastructures* is a compilation of the papers presented at the Fourth Annual Conference on Next Generation Infrastructures held in Virginia Beach, Virginia, in November, 2011. This conference was sponsored by Old Dominion University, Norfolk, Virginia, USA and by the Next Generation Infrastructures Foundation, Delft, The Netherlands. The participants travelled from around the globe to converse about ideas that address both concerns for the present and optimism for the future of critical infrastructures. The conference, held in the USA for the first time, provided a platform for vibrant discussions on multiple aspects of critical infrastructures – infrastructures deemed essential for the functioning of our societies. Thought provoking questions were posed and discussions ensued on a wide range topics ranging from infrastructure vulnerability and resilience, including methods for design and operation, to modelling and analysis, including assessment and evaluation methods. Central to the deliberations was the theme that addressing the concerns of next generation critical infrastructures is a primary challenge for the coming decades. Tested by increasing complexity, scare resources, and emerging threats, the future of critical infrastructure development will continue to be a source of challenges, proposed solutions, and continuing research. This conference provided a venue to identify existing and future infrastructure challenges that must be addressed, to highlight advances in practice and research, and finally to provide case studies on methods to address the future of critical infrastructures.

The first section of this special issue contains papers that highlight critical infrastructure concerns, especially that of infrastructure resilience, i.e., the ability to recover from adversity and return to a functioning state. Natural and man-made disasters throughout the world have demonstrated the importance of critical infrastructure protection and resilience. As part of the process of insuring the resiliency of our critical infrastructures, assessment and measurements must be defined, in order to ensure acceptable performance even during a disaster. Additionally, if the state of resilience is also defined, actions can be planned to return to this desired state during disaster recovery. When there is a critical infrastructure crisis, collaboration and information sharing are essential to continuity of operations. However, barriers to information sharing in a crisis scenario often exist, and the social nature of the resilience problem must also be explored in the context of critical infrastructures. As part of the social context, different observers can be identified through the systems requirements elicitation process. In complex systems such as these, traditional system engineering methods fail to capture the nature of the dynamic operational environment, suggesting the need for a different framework to elicit complex system requirements, which includes the nature of the observer on the final system requirements.

The next section of papers introduces forward looking methods for adapting to the future needs of critical infrastructures. This includes planning for future use, expansion, and conversion of current facilities to future demands and technologies. Strategic decision making models, that can address and balance multiple criteria, including the need to stay viable while addressing sustainability and environmental issues are needed. Also of concern is the dependence on, and usage of energy. In the Netherlands, a midsized city is striving to become independent from all fossil fuels by the year 2020. The goal is to derive all energy required by the city, both commercial and residential, from sun, wind, geothermal or locally produced green grass. This will impact the current infrastructure with the installation of solar panels and harnessing of wind energy. Along with the consumption of energy, the increase in consumer's desire for electronic products, especially mobile phones, is driving changes in both infrastructure and environment, in terms of energy consumed and the CO_2 emissions. Different rates of energy consumption (and the corresponding CO_2 emitted) can be associated with different stages of the product life cycle. Various scenarios can be simulated to evaluate the different impacts on the energy infrastructure, as well as the environment, to plan for future generations. Carbon reduction is also central to enable a more sustainable life style in populated cities. How to motivate the inhabitants of cities, both individuals and businesses, to promote and realise technologies that support the transition to sustainable technology, is another challenge to be explored.

As well as looking to the future, the evaluation and maintenance of present infrastructures is important to meet society's current expectations. Measuring an infrastructure's support to the local populace is key to evaluating its usefulness; by modelling the inequality of infrastructure services within an urban area, the accessibility to infrastructures services can be estimated and evaluated. The positive impact of the road infrastructure is far reaching in most communities, providing accessibility and mobility, but the impact can become negative with negligence and disrepair. The goal for road infrastructures are to keep up to date, well repaired, and outfitted with state of the art technology. One method to address these challenges is through a dynamic control mechanism. Based on complex system and dynamic process control model, the dynamic control mechanism can be used to optimise the total performance of the network infrastructure within the changing world environment. As planners map out needs for current and future infrastructure use, the requirement for models to simulate and predict vehicle traffic also becomes apparent. Models that can simulate vehicle flow on road segments based on vehicular speed and density can assist planners in identifying critical road segments. One of the methods to keep infrastructures maintained and up to date is through the outsourcing of construction and maintenance. Performance based contracting can be used in order to balance the needs of both the asset owners and contractors, with respect to long lead times and uncertainty about the future. Through use of a dynamic contracting mechanism, requirements can be established for both project integrity and performance outcomes in order to manage the increased complexity of infrastructures and provide timely maintenance and improvement.

Finally, the last section of the compilation illustrates some of the critical infrastructure findings in context. Understanding infrastructure networks provides the ability to trace forward to customers and backwards to providers to understand the flow of services. This is especially important, for example, when contaminants enter the food supply network, and it is imperative to both notify potential consumers and identify the source of the contamination. In the same theme, it is useful to know the influence of the environment on infrastructure performance. The impact of heavy rainfall on freeways can impede traffic flow and increase incidents, especially in areas that often experience tropical weather conditions. Adverse weather can severely impact travel and the overall transportation system of a region. Knowing the effect on travel time can assist in planning for traffic management and disaster response. Lastly, the coverage of mobile voice and data networks is of interest to government and consumers alike. Leveraging currently available technology, geographic information system (GIS) mapping, a methodology has been defined to both classify a wireless service region and how to determine the 'coverage' within that region.

Modern society is changing rapidly, demanding more functionality, capacity and quality of our current infrastructures. Our goal is to ensure long-term flexibility for the next generation of infrastructures, while maintaining their stability and reliability. This conference provided a platform to discuss advanced methods and tools for the operation and control of existing infrastructures, as well as the impact of future technological, institutional and social developments.

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