Curriculum on Safety and Security of Civil Infrastructure

Panagiotis D. Scarlatos
Florida Atlantic University, Boca Raton, Florida, U.S.A., scarlatos@civil.fau.edu

INTRODUCTION

The globalization of commerce along with the intensive international transportation of goods and humans created special concerns for the safety and security of the structured environment. Early detection and protection of the expensive infrastructure of high-density urban and industrial areas from natural and anthropogenically-induced catastrophic events as well as development of disaster contigency and recovery planning became a national priority. That requires a new generation of engineering training that incorporates multi-disciplinary education and a different set of mind since the design challenge is moved from the creation of new engineering projects to the protection, maintenance, rehabilitation and strengthening of existing ones. This paper proposes a new graduate degree (MS or Certificate) that focuses on the safety and security of built infrastructure and it made build upon a compatible BS program [1].

SAFETY AND SECURITY ISSUES

The major components of the built infrastructure that needs to be protected from any disastrous events (i.e. hurricane, earthquake, tsunami, terrorist act, etc.) include but are not limited to seaports, airports, subways, major highways, bridges, railroads, utilities, power plants, telecommunications, government buildings and other facilities that are essential to society's well-being and functionality. The task becomes complicated due to the fact that many components of the infrastructure extend over long spatial distances (i.e., tunnels, pipes, cables, etc).

Protection of the built infrastructure requires a sequence of planning steps to provide the necessarry components for its safety and security. At a minimum, those steps require high level and sophisticated development of the following:

- Multi-sensor equipment (acoustic, optic, biological and chemical) for intelligence data collection,
- Methodologies and algorithms for data fusion received from multiple sources (i.e., cameras, satellites, telecommunications, etc.),
- Early detection and deterence systems,
- Public warning and information dissemination mechanisms,
- First response coordination and planning,
- Emergency evacuation routes and alternative options,
- Improved infrastructure resilence, hardening and redudancy,
- Disaster mitigation and quick recovery scenarios,
- Interagency communications and networking,
- Risk analysis and assessment of socioeconomic impacts of a major catastrophic event, and
- Public education, awareness and preparedness regarding the impact of disaster events.

Successful implementation of all the above tasks requires expertise in a variety of multidisciplinary areas involving specialties in engineering, physical, political and social sciences as well as economics and management..

To facilitate the development of this new degree and to assess its applicability, it is preferable to concentrate on a particular aspect of infrastructure safety and security needs rather than being too broad. A prime candidate for this endevor is the safety and security of seaport facilities.

IMPORTANCE OF SEAPORT INFRASTRUCTURE

Maritime trade is a major component of the international economy. For instance, in the case of U.S., approximately 95% of the incoming trade arrives by ship. Each year more than 200 million cargo containers move through major seaports, which is about 90% of the world cargo and it is anticipated that legal maritime trade would triple by the year 2020. In addition to the cargo containers, most seaports are intermodal transportation hubs, where commerce goods and humans arrive and leave by ships, barges, trains, helicopters, buses and trucks. Extensive storage facilities including oil reservoirs add to the challenge of protecting those facilities. Therefore, there is a high vulnerability associated with maritime commerce and the global economy depends on it. It has been estimated that the cost resulting from the closure of a major U.S. port, due to a detonated "dirty" bomb could amount to $1 trillion. Such an event would disrupt the U.S. economy and cause global panic.

Development of a robust safety and security plan would reduce the time of processing through seaports, facilitate legitimate international trade, protect the expensive port infrastructure and safeguard the international economy.

PROPOSED CURRICULUM OF STUDIES

The proposed curriculum is at the graduate level leading to a MS or Certificate in Seaport Safety and Security. The graduate from this program will receive 30 credits of semester coursework and 3 credits of research. The curriculum will be designed for students with an undergraduate degree preferably in civil, mechanical,

electrical or computer engineering. Students from other engineering or science backgrounds will need to take some undergraduate background courses according to the required prerequisites.

The ten 3-credit courses will be divided into four mandatory core and six elective courses as follows:

Core Courses

The following are the general education background core courses with a brief description of their content (listed in parentheses):

- Seaport Operation and Management (container, cargo and cruise terminals; terminal staffing, automation and information systems; contract negotiations; port infrastructure)
- System Analysis and Optimization Techniques (system reliability; in-series systems; in-parallel systems; load sharing and standby redundancy; failure modes; improving reliability; maintenance policies; life cycle analyses; optimization)
- Advanced Structural Materials (advanced composite materials; high temperature materials; fatigue; ductile overload; brittle fracture; creep; corrosion; blast resistance)
- Safety and Security of Seaport Facilities (maritime threats and crime; illicit smuggling; terrorism; sabotage and vandalism; threat mitigation: prevention, minimization and identification; security training and equipment; perimeter security; access/egress control; screening)

Elective Courses

The elective courses will provide specialized information on various topics related to safety and security and will be selected from the following list:

- Acoustic and Electronic Sensors (transducers; piezoelectric materials; semiconductors; microelectronics; acoustic waves; signal processing; sonic analysis)
- Optics and Optic Sensors (fiber optics; laser optics; Doppler effects; optical absorption; photoelectric sensors; infrared and ultraviolet spectrum; charge couple devices)
- Data Fusion and Fuzzy Knowledge (statistical analysis with missing data; fuzzy modeling and control; self-organizing data fusion; hierarchical knowledge; neural networks; multi-sensor data fusion; pattern classification and scene analysis)
- Traffic Flow Analysis and Emergency Evacuation (simulation models of traffic flow; traffic assignment; traffic delay; contra traffic flow; network performance; driver behavior; classificatory reasoning and certainty value; evacuation of passenger ships; intermodal transportation evacuation routes; dynamic dissemination of evacuation information)
- Simulation of Disaster Scenarios (hurricanes; earthquakes; tsunamis; conventional bomb explosion; detonation of a "dirty" bomb; assessment of infrastructure damage; short and long period effects; computer visualization; first response; mitigation planning)
- Risk Analysis (risk assessment; risk characterization; risk management; risk communication; risk-related policy making; physical, chemical and biological threats; temporal and spatial risk scales)
- Interagency Cooperation and Communications (communication networks; local, state and federal agencies; community and private industry involvement; first responders; chain of command; capital wireless integrated network; emergency centers; general incident, law enforcement, fire and medical emergencies, and missing persons bulletin boards)
- International Trade and Economics (international trade theories; regulation of international trade; economic and political trade risks; free trade areas; trade pacts; customs; globalization; outsourcing)
- Management of Cargo Container Terminals (financial and cost modeling; design of terminal layout and logistics; automated operations and procedures; gate and rail handling design; IT systems; computer simulations and validations; "smart" containers)
- Applications of GIS and GPS on Seaport Operations (GIS mapping of port facilities; dispatching and tracking of hazardous and high-value cargo containers; geospatial intelligence; web-based GIS dissemination, analysis and visualization; automated container clearance and gate security; fleet management; video surveillance)
- Chemical, Nuclear and Radioactive Warfare (nerve agents: VX, Tabun, Sarin, Soman; mustard agents; phychotomimetic agents: BZ; arsines; toxins; hydrogen cyanide; nuclear and radioactive materials; detection and treatment)
- Biological Warfare (anthrax, botulinum toxins; brucellosis; *Clostridium Perfringens* toxins; cholera; Congo-Crimean hemorrhagic fever; smallpox; tularemia; detection and treatment)

In addition to the coursework the student will be required to successfully complete a project. The project would involve simulation of "real-life" situation from a selected port as related to safety and security issues. All of the projects will involve active participation of port personnel as well as personnel from other law enforcement, environmental, transportation, public health or community affair agencies and/or the private industry. The student will have to write a report and make a presentation of the project to a graduate review committee.

REFERENCES

[1] Scarlatos, P.D., 2006. Baccalaureate Studies in Maritime Engineering and Management, LACCEI 2006.