

UTILIZING LIFE-CYCLE ENVIRONMENTAL ASSESSMENTS FOR IMPROVED PRODUCTS AND PROCESSES: LEVERAGING THE TECHNOMILITARY MODEL

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ABSTRACT

The Urban Operations Laboratory (UOL), comprised of M2 Technologies, Kansas State University, and CABEM Technologies, performs environmental research, training, assessment, and product development for the Department of Defense (DoD). One of UOL's tasks is to assist DoD in conducting programmatic life-cycle environmental assessments (LCEA) during the acquisition phase of technology development. UOL addresses complex human health and ecological challenges that affect natural and cultural resources. As part of the LCEA work, multidisciplinary groups coordinate with DoD's Integrated Product Teams (IPTs) and Human Effects Review Board (HERB) to provide technical input on potential environmental health and safety concerns and participate in design, demonstrations, field testing, data collection, analysis, and interpretation. Efforts to further enhance assessments with respect to interdependent military readiness and eco-socioeconomic aspects via triple bottom line sustainability analysis are being pursued. UOL developed the Environmental Knowledge and Assessment Tool (EKAT) for the United States Marine Corps and has enhanced it for wider public and private sector applications. EKAT is used by collaborating professionals as part of the LCEA analysis. This paper highlights methods by which UOL conducts LCEAs by presenting examples from several current and ongoing projects. Moreover, beyond the technomilitary sphere, this efficacious model can be utilized for improving other industrial and commercial products and processes, including various oil and gas projects.

URBAN OPERATIONS LABORATORY

Background

In 2001 Congress appropriated funds to establish the Nonlethal Environmental Evaluation and Remediation (NEER) Center at Kansas State University. The successful consortium was subsequently expanded into the UOL to support dynamic military needs through practical environmental assessments,

software tool design and development, and innovative technology development. UOL performs environmental analysis for its military partners in accordance with international, federal, state, and local regulations and policies, including: DoDI 5000.02 (Operation of the Defense Acquisition System) (1), DoD Military Standard MIL-STD-882D (Practice for System Safety) (2), the National Environmental Policy Act (3), and Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation Management (4), among others. Further information is available at www.uol.ksu.edu.

Approaches and Tools

Working closely with DoD Integrated Product Teams and the Joint Non-Lethal Weapon Directorate (JNLWD) Human Effects Review Board, UOL is able to provide technical input and assistance throughout the design and development process. Through an iterative approach involving multidisciplinary professionals, including scientists, engineers, toxicologists, safety professionals, and military analysts, UOL is able to effectively leverage a variety of resources and methods. In addition to the Environmental Knowledge and Assessment Tool (EKAT) (5), various DoD databases and Environmental Protection Agency (EPA) models are utilized with special attention to green engineering principles. Empirical multimedia sampling and analysis are often performed by the team to supplement available experimental data and simulated and predictive data sets.

Technologies and Capabilities

To date, several innovative technologies, devices, and systems have been successfully evaluated at various phases of acquisition. Given the established user need for these nonlethal technologies and their integration, the capability to assess these systems in the context of unintended human health and ecological impacts is critical.

U.S. MILITARY AND THE ENVIRONMENT

Transformation

Early in the 19th century, aspects of environmental management were integrated into the American military mission, including the Lewis and Clark Expedition (Corps of Discovery). As military activities, equipment, and facilities became more complex and mechanized, the needs for effective natural resource conservation and environmental stewardship were slowly being recognized. In terms of environmental quality and prioritization, there has been a transformative progression from early command and control approaches with regulatory drivers, to more recent preventive measures with overarching sustainability objectives. In 2008, the Army issued its first sustainability report, which is the first report from any major federal agency to follow the Global Reporting Initiative's sustainability reporting framework (6).

Four Focus Areas

Military environmental programs are administered through four primary focus areas: 1) conservation, 2) restoration, 3) compliance, and 4) pollution prevention. The tremendous technical and financial challenges of investigating and remediating historic/legacy contamination sites demonstrate the need for strategies and tools that integrate environmental considerations much earlier in the technology development cycle (7).

ENVIRONMENTAL KNOWLEDGE AND ASSESSMENT

The Environmental Knowledge and Assessment Tool (www.ekat-tool.com) is an automated web-based tool designed by the UOL Consortium to identify, research, and evaluate environmental and pollution prevention options, and safety-related issues for products and systems (8). Originally a concept jointly developed with the Marine Corps System Command in order to better integrate environmental requirements into the systems acquisition program, to support DODI 5000.2, the tool's features also make it useful to other public and private sector organizations. EKAT is organized to conveniently compile basic information on technical and regulatory requirements and serves as a resource center linking to other references, tools, and databases to assist in research efforts to minimize any unintentional safety and environmental effects associated with product use. Key modules and capabilities of EKAT include the following:

- Environmental screening. The environmental screening feature allows the user to evaluate chemicals or materials for potential environmental compliance and safety and health issues by comparing chemicals to federal environmental regulations and other pertinent lists.
- NEPA Decision Tree. The National Environmental Policy Act (NEPA) module assists military users in meeting federally-mandated requirements to consider environmental and related issues in proposed actions.
- EmisCalc. EmisCalc allows the user to estimate actual air pollutant emissions or calculate the potential emissions for processes using EPA-approved air emission factors from the EPA Factor Information Retrieval database.
- TRACI for EKAT. TRACI for EKAT Tool is a modified version of the EPA software tool, The Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), which allows the user to evaluate the environmental impact of releases to air and/or water over the lifecycle of a product, helping the individual understand and mitigate future liability.
- PESHE Report Generator. Military users utilize the Programmatic, Environmental Safety and Occupational Health Evaluation (PESHE) module to guide analysis and preparation of the comprehensive ESOH report, as required by the Department of Defense for all programs, in support of DODI 5000.02.
- EKAT Wizard. The EKAT wizard feature is set up in a question and answer format to guide users and help them determine which assessments, tools and other EKAT resources can help best address their requirements.

EKAT contains additional research options, including information resource documents and guides, providing the user with quick access to myriad resources for investigating material properties, reviewing specific ESOH regulations and databases, finding pollution prevention alternatives, as well as providing links to other Internet resources on topics of interest.

LCEA METHODOLOGY AND APPROACH

Initial Characterization

Clearly understanding the proposed technology concepts, materials and byproducts, and intended uses are important. Determining potentially applicable regulations and acquiring key data are performed with tools such as EKAT. Potential impacts are qualitatively estimated and baseline information is compiled.

Evaluating Impacts

Evaluating environmental impacts for a proposed action or technology is the heart of the environmental assessment process. Interdisciplinary teams of subject matter experts systematically collect and evaluate theoretical and empirical data to further predict, quantify, and assess any unanticipated impacts. At this stage, information is synthesized to ascertain the level of significance. Preliminary findings are then analyzed, along with any needed mitigation measures.

Decision-Making

Tentative recommendations are shared with military and technology leaders for preliminary input with respect to selecting the proposed action or technology.

Documentation

Based on proponent feedback, draft reports, such as an LCEA or PESHE, are cooperatively completed. As part of this process, monitoring and oversight plans are incorporated. Programmatic recommendations are completed and used as technical resources for further site-specific/geospatial evaluations and local public involvement. The methodology of life cycle environmental assessment is mindfully integrated throughout the system development and procurement life cycle. The acquisition continuum provides several opportunities for both formal and informal environmental analysis, thus contributing to technology maturation while addressing environmental quality.

During initial planning and design, UOL professionals review the capabilities and requirements. Environmental experts are part of the IPT from the beginning. Efforts are initiated on PESHE construction prior to system development and demonstration. Environmental specifications and attributes are an integral part of prototype development. During field testing, data are collected to update and confirm predictions and verify compliance with standards. Considerations for deployment, transportation, and storage activities are carefully implemented. Before fielding and production, formal program assessments are completed. This information is provided to military installations for site-specific analysis. Given the holistic methodology, demilitarization and disposal actions are proactively evaluated to minimize waste generation and maximize reuse and recycling back into the technology sphere.

OIL, GAS, AND OTHER ENERGY OPPORTUNITIES

Given the current economic and energy challenges (e.g., global recession, precarious and emerging markets, geopolitics, climate change, etc.) facing the U.S. and the international community, strategies to improve cost and schedule efficiencies, while reducing liabilities are crucial. Traditional oil and gas operations, from well to wheels and beyond, present lucrative opportunities to use this systematic methodology and determine fully burdened costs. In particular, exploration, production, refining, transportation, and performance hazards and risks can be addressed. Moreover, alternative and renewable energy projects can benefit by incorporating these concepts into early tradeoff analysis. By bringing

together diverse teams of experts and users/customers for scoping and holistically mapping processes, unintended impacts can be identified for further evaluation and stakeholder engagement/input. This can facilitate technical, regulatory, and social (cross-functional) dialogue; thereby galvanizing empowerment and creative problem-solving for long-term energy needs.

NON-LETHAL TECHNOLOGIES

Background

Prior to 1995, non-lethal technologies had been used primarily in specialty law enforcement applications. The successful utilization by U.S. Marines in 1995, to assist the safe withdrawal of United Nations Peacekeepers in Somalia, served as a pivotal event in establishing the efficacy of their use. The Pentagon issued a policy directive codifying the development and employment responsibilities for non-lethal weapons systems (9). It designated the U.S. Marine Corps as the Executive Agent and provided official definition, “Weapons are explicitly designed and primarily employed so as to incapacitate personnel or materiel, while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment.” The following year, the DoD Joint Non-Lethal Weapons Program (JNLWP) was created. Asymmetric and decentralized threats have further contributed to the need for these enhanced security capabilities (e.g., crowd control; checkpoint and convey operations; humanitarian relief; etc) (10). Partnering with the JNLWP, UOL has supported the advancement of several non-lethal systems and tools, of which three are highlighted below (11).

Mobility Denial System/Anti-Traction Material

The Mobility Denial System/Anti-Traction Material project is a Marine Corps led program using a water-based slippery gel material which when sprayed on surfaces is designed to preclude and/or minimize access to designated areas by individuals and vehicles. UOL evaluated early formulations and identified potential chemicals of concern. Support activities included developing a geographic information system (GIS) suitability training tool, sampling and analysis, risk assessment, installation consultation, etc. Based on findings, the gel material was optimized, and personal protective equipment and best management practices were incorporated.

Aroma and Odor Compounds

Aroma and odor compounds are foul-smelling mixtures used for targeted delivery as area clearing mechanisms. UOL identified problematic constituents in formulations and reviewed conventional and novel delivery subsystems for various DoD agencies. Release scenarios were estimated and safe concentrations were calculated to assist technology development. Recommendations for payload enhancement, ecotoxicity testing, and controlled release delivery were completed.

Flash-Bang Grenades/Non-Lethal Airburst Munitions

For this joint forces program, early small-arms launch platforms and payloads were assessed by UOL. Based on input, problematic compounds were eliminated. Improved flash-bang pyrotechnics have been developed as the basis for these versatile systems. Limited field sampling and analysis, in test chambers and ambient conditions, were completed. Innovative metal-based payloads, fuzes, and activators are currently being analyzed. UOL is involved with several variations, including: hand

delivered, single shot, and multiple fire applications of this multisensory (light, sound, and heat flux) technology.

CONCLUSIONS

Based on the successful public-private framework followed by UOL, several instructive lessons can be derived.

- 1) A strong commitment to stewardship and sustainability from organizational leaders contributes to an enduring ethos of quality and dynamic balance (top down).
- 2) Strategic life-cycle environmental assessments, integrated during systems development and procurement, have been demonstrated to elevate triple bottom line priorities (environment, economics, social) while also driving innovation at the operations level (bottom up).
- 3) Early partnership and cooperative involvement are essential to effective planning and implementation, utilizing both multidisciplinary teams and robust data tools. These upstream collaborative efforts can lead to improved products and processes, while minimizing unintended environmental and safety consequences (proactive rather than reactive).
- 4) Efficiencies can be captured by streamlining and leveraging efforts between stakeholder groups with similar objectives, thereby fortuitously breaking barriers, building capacity, and creating synergy. Examples include: joint services testing requirements rather than fragmented redundancy; combined environment, safety, and occupational health data sharing; transdisciplinary research, development, and knowledge dissemination (doing more with less).

Overall, with growing economic, environmental, and energy constraints throughout society, pragmatic approaches to product development and decision-making, such as the UOL methodology are vital.

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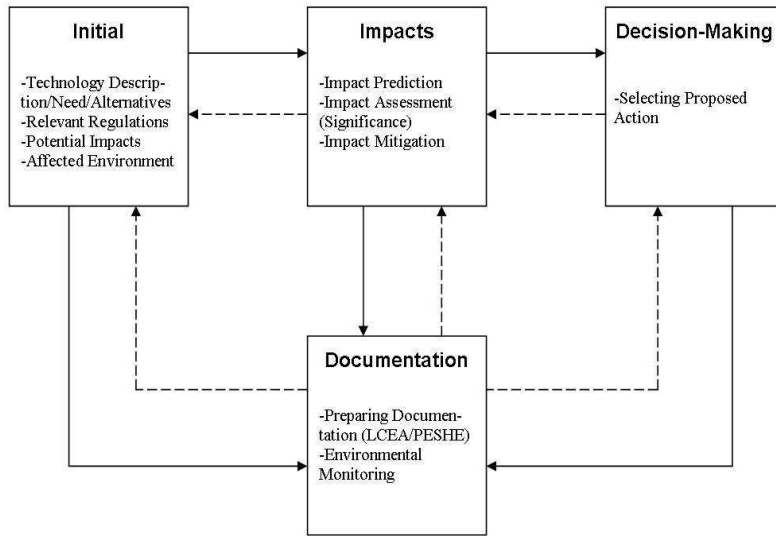


Figure 1. Conceptual Framework for Life-Cycle Environmental Assessment.

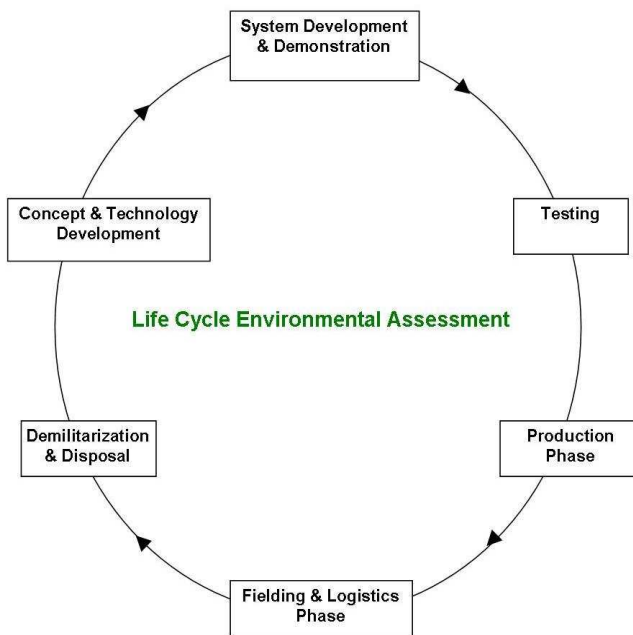


Figure 2. Acquisition Continuum and Integrated Life-Cycle Environmental Assessment.

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