

SBIR/STTR TRANSITION PROGRAM

SPOTLIGHT

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Artificial Intelligence Revolutionizes Mine Countermeasures Planning and Replanning

By Jennifer Reisch

As part of the mine clearing process, mine countermeasure (MCM) commanders (MCMC) and their staffs plan for and task a variety of assets in a volatile environment while balancing risks against operational objectives. This decision-making planning is predominantly manual, limiting the number of courses of action considered and slowing the ability to respond to disruptive events once operations have begun. “Mine clearing activities occur during both peacetime and wartime. When commanders are tasked with clearing an area of water, an operations plan is developed, which currently they do manually,” said Kalyan Moy Gupta, Ph.D., president and founder of Knexus Research Corp. (Knexus). “It takes a staff of half a dozen specialists a day just to create one plan, which they then go back and iterate with their commander. It’s a lot of man hours of effort to plan MCM operations.”

These decision-making tasks include preliminary scheduling and course of action analysis to create missions, tasking various assets, progress monitoring and subsequent replanning to adjust for any disruptions. The complexity of decision making for MCM operations is substantial given the size of the operation area, long durations of the missions, and the number of assets

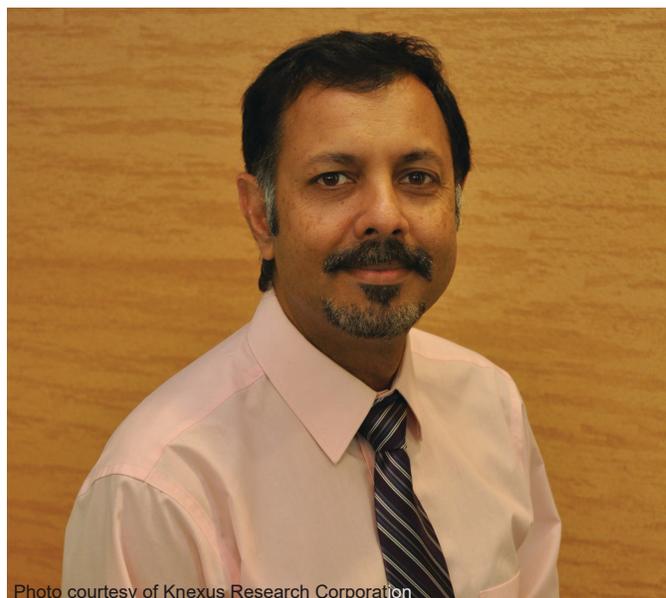


Photo courtesy of Knexus Research Corporation

Kalyan Moy Gupta, Ph.D., president and founder of Knexus

and resources that must coordinate with each other. And the planning process is getting more complicated. “The difficulty of making decisions in such an unpredictable environment will worsen as the new MCM doctrine is implemented with unmanned vehicles and a reduction in manning. Automation for decision support and streamlining information flow between planners and task units performing missions is needed to sustain current and future operations,” said Gupta.

Knexus was awarded SBIR N121-082 to

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address the need to improve MCM planning and replanning. “Lack of automation is a major problem. It takes too long to respond. Because the process is manual, teams can explore only a very few options. Choosing the best of them is very hard, especially under time constraints. The gravity of the

challenge to make planning technologies robust was great enough that the Office of Naval Research created a Future Naval Capabilities (FNC) program called Task Force Planning to fund additional research and development. Dr. Jason Stack initiated the ONR FNC and now Dr. James (Tory) Cobb is the current ONR 321 FNC program

manager. They were incredibly farsighted in their vision for developing a lasting solution for our warfighters and steadfast in their commitment to this program for almost a decade despite the funding challenges that arise in such long-term research. We are thankful for their support toward getting our solution into the hands of the warfighter.”

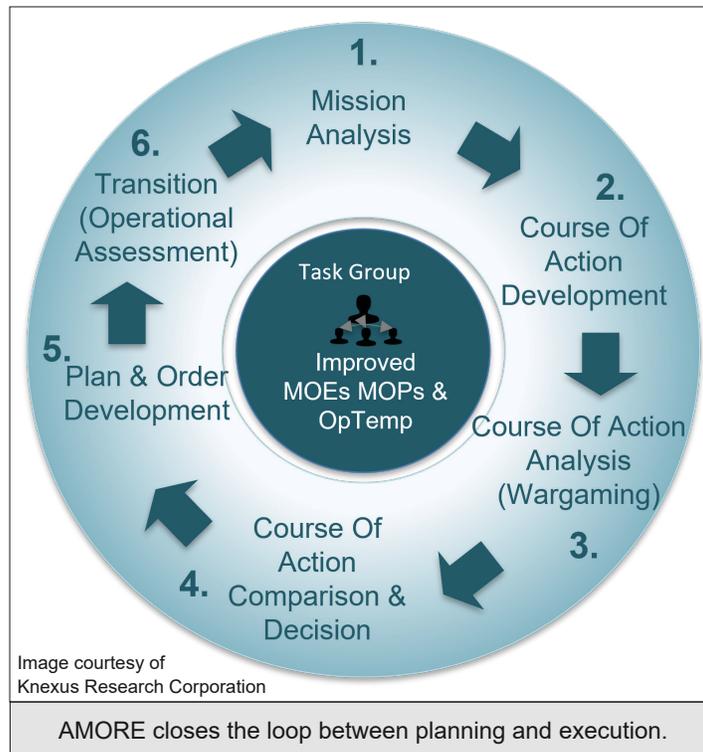
Knexus developed artificial intelligence (AI)-based Adaptive MCM Operations Planning & Re-planning (AMORE), a

patent-pending decision support tool and system that integrates all MCM operations management decision tasks, including preliminary scheduling, situation assessment, and rescheduling. The technology will reduce mission planning and re-planning time, offer many more

options, and prevent scheduling conflicts of platforms and warfighters. It focuses on automating decision making for situation monitoring and analysis, and subsequent replanning or repair functions.

“The AMORE technology is a promising approach to speed up operational decision-making by

employing tools from machine learning. This work aids mine warfare commanders by automating many labor-intensive tasks such as planning and re-planning ships, aircraft and autonomous systems in a dynamic environment. Automating these tasks allows the battle staff to update operational plans and provide commanders with potential courses of action much faster than our current timeline. These artificial intelligence tools developed by Knexus are critical elements in a strategy to transform future military operations,” said James (Tory) Cobb, Ph.D., ONR Code



321 program officer.

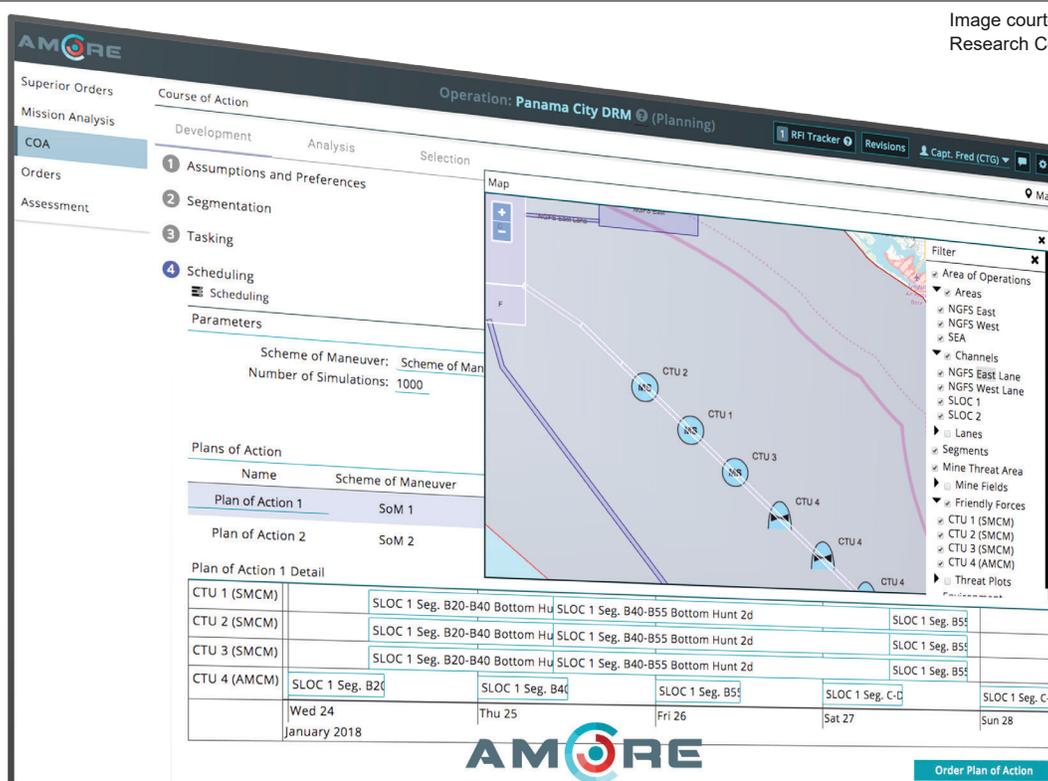
“Navy task group commanders develop and evaluate courses of action with rationale in minutes instead of days with our AI and machine learning algorithms for automated planning, plan learning, and situation assessment,” Gupta said.

AMORE is a suite of various components that support and automate planning. “A key aspect of that is a very advanced AI-based planning system which we call multi-domain/multi-echelon operations planning and replanning.” The technology reduces mission replanning time and improves overall mission performance, providing:

- Faster and more effective rescheduling in response to disruptive events
- Application of constraints on assets and operators
- Better evaluation of risks and uncertainty
- Fluid interactions
- Decision transparency

It continuously detects and analyzes subtle but important deviations and recommends task and schedule adjustments. AMORE is targeted for insertion into the Mine Warfare and Environmental Decision Aids Library (MEDAL); however, it can be integrated with other mission management systems for improved asset utilization,

Image courtesy of Knexus Research Corporation



AMORE is an AI algorithms-based tactical decision aid for task-group and task-unit commanders that reduces planning and replanning effort and time, and improves plan quality and overall measures of effectiveness

reduced operation duration, and reduced warfighter risk.

“The AMORE software targets and automates many of the mundane and tedious tasks undertaken by MCMC staffs, which dramatically decreases the necessary decision-making timeline. Data is a strategic asset that is key to the DoD maintaining technological superiority. Knexus brings cutting edge artificial intelligence and machine learning algorithms to the data to provide scientifically informed decision-making capabilities, while at the same time allowing for the commander’s discretion to be exercised,” said Jeremy Hatcher, Ph.D., branch head, Naval Surface Warfare Center Panama City Division (NSWC PCD). “Dr. Gupta leads an extraordinary team of highly qualified individuals who thoroughly understand Navy tactics, techniques, and procedures as utilized by MCMC staffs.”

AMORE helps group commanders plan a mission to clear a designated area in the required time frame at an acceptable risk level with the available assets, such as helicopters, ships, divers, and undersea vehicles with different capabilities. Information including situational estimates of what the enemy has done, what mines are where, and ocean depth go into the plan, which determines who needs to clear what in which areas, when, and in what order. Once things are put in motion there is continuous situational assessment and

replanning which can last a few days to a few weeks depending on how large the area is that must be cleared. “As soon as a team starts executing things may not be what was expected and therefore need to be adjusted. Mines may be found that are different than what was estimated based on their intelligence or there may be a different number of mines in different areas. This requires constant adjustment, which also takes an enormous amount of time. They have to monitor what’s going on 24 hours a day,” Gupta said.

The software will dramatically streamline MCM operations and improve mission effectiveness by reducing risk to the warfighter, improving the warfighter’s ability to detect subtle but important anomalies hours earlier than is currently possible. This will lead to better asset utilization and reduced mission time. The efficiency and effectiveness gains will be even greater with unmanned platform operations. “In a world being made smaller everyday by the cloud’s reach, Knexus has seamlessly leveraged this mechanism to provide decision-making tools to geographically disparate organizations in an efficient and secure manner,” Hatcher said.

The system is capable of addressing any equipment or tactics change; technicians can change the tactical performance database themselves without having to adjust anything on the AI software.

AMORE technology can be applied to

improve and streamline operations planning and management in civilian and other national agencies that operate in dynamic and uncertain environments, including crisis management, forestry and fire fighting operations management, and law enforcement operations planning and management. “The technology is a planning engine. By changing the application domain and data the technology can very easily be used for something else, such as air operations planning or carrier deck planning or even in commercial settings, such as logistics or crisis response planning,” Gupta said. “The capabilities provided by AMORE are seminal and unique not only for MCM operations planning but also in the broader context of mission planning in other domains. To our knowledge there is no other AI planner of this depth.”

Knexus is currently conducting several tests based on data and criteria set by PMS 495. “We have a technology deployment agreement, a TDA, in place and we are on track to meet that goal and we will deliver all the components by September. NSWPCD is guiding us and assisting us with evaluation and transition. They are currently preparing a plan for further deployment and for transition to deliver this set of tools. Dr. Jeremy Hatcher and Dr. John Hyland have been great advocates and champions on behalf of ONR and the Navy. They have provided invaluable support and guidance to our team throughout the technology development and test and evaluation, and are coordinating with the MCM tacticians

at NSWPCD for a successful transition,” Gupta reported.

By participating in the DoN SBIR/STTR Transition Program (Navy STP), Knexus made several contacts at the DoN Forum for SBIR/STTR Transition (Navy FST) with strong interest in mission planning technology. “We’ve been able to find other very interesting potential opportunities. Team members were helpful and supportive in helping us prepare our materials all the way through the Navy STP. They were extremely encouraging.”

Knexus Research Corporation is an 8(a) small disadvantaged business and a pioneer in AI, machine learning (ML), and data privacy research and development located in National Harbor, Maryland, that specializes in provable innovation via research and development (R&D) of autonomous and intelligent decision support systems (DSS). The company mission is to deliver intelligent and innovative software solutions that measurably improve decision support effectiveness and autonomy levels. Knexus staff includes over a dozen individuals with doctorates and master’s degrees in computers, data science, and applied mathematics with broad and deep software engineering expertise. For more information, visit <https://knexusresearch.com/>.

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