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DART: Revolutionizing Logistics Planning

By Sara Reese Hedberg

For the last two hundred years, the dominant force in international affairs has been the nation state. Most wars have been caused by attempts to create or expand such states. In contrast, over the next twenty years, the risks to international stability seem as likely to come from other factors: ethnic and religious conflict; population and environmental pressures; competition for scarce resources; drugs, terrorism and crime ... the consequences of initially local crises may spread dramatically throughout an ever more interdependent world.[1]

—*Tony Rathmell*

Planning and implementing an effective military response to a crisis is a highly complex problem. There are a host of interdependent factors to consider—from the high-level strategic planning of an evolving crisis situation, to the nuts and bolts of moving people, machinery, and supplies.

When the Allies invaded Normandy on 6 June 1944, more than 15,000 vehicles and 155,000 troops stormed five beaches—after two years of preparation. By contrast, Desert Shield/Storm in 1990–91 was the largest, fastest, and farthest sealift to a single locale in the history of warfare—and there was no prior buildup of troops or supplies. The US Department of Defense sealifted 2.4 million tons of cargo during the first six months of Desert Shield—more than four times the cargo carried across the English Channel to Normandy during the D-Day invasion and more than 6.5 times that of the peak force buildup during the Vietnam War in a single period.[2]

Reflecting the changing geopolitical environment at the cusp of the 21st century, the military's role has changed. Most modern military engagements are no longer thought of in terms of the victor and vanquished, but rather in terms of stabilizing conflict situations. Fiscal constraints and downsizing have also changed it. Add aggressive investments in information technology, and the result is a military trying to reshape itself as fast as the moving target of global politics.

Most Department of Defense documents no longer focus on the battlefield but rather focus on the more all-encompassing battlespace of a highly complex physical, psychological, and electronic "theater." Military power is more than brute force or orchestrated mechanical might now. It involves international coalitions of forces with military, electronic, mechanical, and humanitarian capabilities that can effectively quell crises under the intense scrutiny of international monitors and the media's watchful eye (see the Knowledge Systems from Coalition Operations articles starting on page 14 for more information).

An AI legend

As Desert Shield was getting underway, Ted Kral, a program manager at BBN Technologies, hatched the idea for an AI-based decision support system to help humans plan the movement of equipment and personnel from Europe to Saudi Arabia. His idea resulted in the Dynamic Analysis and Replanning Tool, a landmark AI application—both in terms of its organizational impact and return on investment. The DART scheduling application paid back all of DARPA's 30 years of investment in AI in a matter of a few months, according to Victor Reis, Director of DARPA at the time. DART compellingly demonstrated that AI, when strategically embedded in larger systems, could result in orders-of-magnitude improvement in planning.

To fast-track his idea into a deployed application in time to meet Desert Shield's needs, Kral led a skunk works team at BBN with help from Ascent Technology, SRA, and ISX. "[The team] developed the system in a grueling challenge to compress an 18-month development effort into a 10-week development and test and then deploy [effort]," he says.

About halfway through the six months of Desert Shield, Kral installed the system at the USTRANSCOM transportation command and the US European command, where it was used for the duration.

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DART was quite revolutionary in 1990, replacing a mainframe planner using Job Control Language and reams of printouts. It was a GUI-based scheduler that took a mainframe flat file of the details of all items to be moved—dates to move, places to move to and from, and so forth—and loaded the data into an Oracle database. The scheduling was done on a front-end Sun-4 workstation. It enabled users to examine schedules at a higher level of abstraction, because it could readily aggregate modules. Further, it let users for the first time inspect, modify, and interact with the planning system. This was precluded by the previous black-box JCL-based system.[3] Planners could run strategic transportation models using DART in a matter of minutes rather than in hours or days. This enabled them to consider more alternatives and develop a more realistic action plan in far less time.[4]

"The overall logistics effort to mobilize and support Desert Shield/Storm was Herculean, especially in the weeks prior to initiated hostilities," said Gen. H. Norman Schwartzkopf, US Commander-in-Chief, in April 1991. "The superb performance of the logistics community deserves high praise."[5] Thanks in part to DART.

DART was the first demonstration system to emerge from the ARPA-Rome Knowledge-Based Planning and Scheduling Initiative which was formed in 1990 and spearheaded by Northrup Fowler of the Air Force's Rome Laboratory, and Steve Cross, then at Advanced Research Projects Agency. The Initiative was created to develop next-generation AI tools for planning, scheduling, and resource allocation to improve crisis management planning. By the mid 1990s, ARPI had been highly successful not only in technology innovation but also in insertion into various user communities, as well as spawning commercial applications and other initiatives.[6]

Military coalitions

Desert Shield/Storm was historically significant in portending a military future of coalitions. Thirty nations joined against Iraq, with an additional 18 countries supplying humanitarian, economic, or other types of assistance.[7] "The information and systems needed are now very coalition-focused," says Nort Fowler, now acting chief scientist at the Air Force Research Lab's Information Directorate. "All future foreseeable campaigns will involve coalitions. That's a fact of life. Everyone recognizes that it is a different world today."

The military's changing face adds new layers of complexity to planning and executing diverse and highly complex missions. Decision-makers need to collaborate with all relevant partners to plan for situations with multiple concurrent operations. This produces a whole new set of issues and constraints wrought by the diversity within the coalition, including

- Differing cultural and religious sensitivities ("You don't want to put a Big Mac hamburger in the hands of Indians who consider cows sacred," as one source explained it).
- Different military rules of engagements.
- Varying information classification and releasability restrictions—a government might not want to release all information to all coalition members. For the US military, the releasability policies and protocols are outlined in great detail by the State Department, and must be followed in conflict and peacetime. There are also layers of releasability. A bilateral agreement between the US and Great Britain, for instance, might be more liberal than a multilateral agreement between all the English-speaking nations.
- Diverse organizational responsibilities (military, relief, public health, humanitarian, peacekeeping, monitoring, domestic law enforcement, and so on).
- Widely differing computer systems and services.

Interoperability of disparate distributed decision support systems is necessary to help address these issues and render a responsive, coherent whole. Defense organizations are looking to create information tools and services to facilitate knowledge production, distribution, and understanding as well as to enhance internal and external collaboration.

A new generation

Military agencies around the world are finding that knowledge systems offer powerful, effective tools to deal with the increasing complexities they face. A new generation of intelligent systems research and applications is emerging that focuses on coalition management. Much of this work, an outgrowth of projects started as part of ARPI (which spawned DART), draws on a broad range of knowledge system tools and research such as intelligent agents, knowledge management, natural language, expert systems, and knowledge engineering.

"Knowledge systems, encompassing a wide variety of agent-based and knowledge-based systems, can contribute to coalition operations in multiple ways" explains Lt. Commander Dylan Schmorrow, DARPA's Program Manager of the Control of Agent Based Systems (CoABS) program, "primarily through the capture of and representation of knowledge in such a manner that automated processing and display of such information can be made with limited human attention. Through such automation, the handling, movement, and quality of information can be greatly increased."

"Two examples of such processes that are important for coalition operations are that of policy control for the release and dissemination of information and the reduction of time-consuming human interpretation [both language-to-language and various information-handling processes such as fusion of disparate sources]," Schmorrow says.

"Much of what is involved in coalition operations is the exchange of information between systems that were not designed to work together," says Jim Hendler, a professor of computer science and electrical engineering at the University of Maryland, and a pioneer of intelligent agent re-search. "Agents can help a system to query for information from other systems without knowing explicitly where it resides or in what format. We are thus able to have a flight planner implemented by the British interact with US systems for refueling, and systems from other countries to provide information about the locations of various military assets." ■

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