

Land warfare--a complex adaptive system

As a means of understanding land warfare in a fundamentally new way, CNA is exploring developments in complex adaptive systems theory--particularly the set of simulation tools being developed by the artificial-life community. Land warfare possesses all the key features of complex adaptive systems:

- Combat forces comprise a large number of nonlinearly interacting parts organized in a command and control hierarchy.
- Local action, which often appears disordered, induces long-range order; i.e., combat is self-organized.
- Military conflicts, by their nature, are not in equilibrium; rather, they typically proceed far from equilibrium conditions. In order to survive, military forces must continually adapt to a changing combat environment.
- No *master voice* dictates the actions of each and every combatant; i.e., battlefield action effectively proceeds according to a decentralized control.

Despite these facts, the primary focus of most current models of military conflicts remains simple force-on-force attrition. Our focus is on exploring how two forces *co-evolve* during combat, as opposed to simply examining the final outcome of a battle by measuring surviving force strengths. To that end, CNA is developing EINSTEIN, a PC-based multiagent simulation toolkit for exploring self-organized emergent collective behavior in combat. EINSTEIN is designed to explore the evolving patterns of macroscopic behavior that result from the collective interactions of individual agents (soldiers, squads, tanks, etc.), as well as the feedback that these patterns might have on the rules governing the individual agents' behavior. EINSTEIN is one of the first

applications of this new modeling approach to focus on a specific area of interest to military operations research. Other areas that may benefit from this complexity-based simulation technology include logistics, manpower, infrastructure, and general organizational structure. (Dr. Andrew Ilachinski, (703) 824-2045)

E-2C support to counter-drug operations

In addition to training and supporting carrier deployments, U.S. Navy E-2Cs routinely support counter-drug (CD) operations. Over time, sustained operational demands have resulted in PERSTEMPO for E-2C squadrons that is among the highest in the aviation community. E-2C PERSTEMPO, averaged across all squadrons, is 48 percent--just under the maximum allowable (50 percent). But the average does not accurately represent the reality faced by some squadrons. CNA examined historic E-2C employment data and found that squadrons that support CD operations are more likely to exceed PERSTEMPO than those that do not.

Further, E-2C squadrons supporting CD operations exceed another, equally important, factor. In his quality-of-life initiative, the CNO limited the time away from home during the inter-deployment training cycle to 28 days per quarter. We also examined future deployment schedules and CD support requirements and found that, during future IDTCs, most active-duty E-2C squadrons will likely exceed the limit on time away from home. To eliminate these *IDTC busts*, active-duty E-2C support to CD operations will have to be reduced substantially. OPNAV (N51) is pursuing a course of action to replace active-duty E-2C support to CD operations with other means, such as increasing Reserve participation or outsourcing some CD support to contractors.

(Dr. Barry Howell, (703) 824-2041)

Reducing the cost of health-care training

Every year the Navy trains more than 1,500 active-duty enlisted hospital corpsmen and dental technicians in specialized health-care fields at a cost of about \$38,000 per trainee. About half of the training programs are for military-unique specialties. But the other half are programs for which the civilian sector offers comparable training. Navy Medicine asked CNA to examine the cost-effectiveness and feasibility of using civilian training programs.

We found that significant savings could be realized in some smaller programs by recruiting civilian-trained specialists; and in some larger programs by using a combination of contractor training for current active-duty personnel and new recruits with civilian training. These approaches could reduce training costs by 40 to 70 percent, depending on the specialty. Navy Medicine is currently developing a contract to outsource x-ray technician training and is pursuing opportunities for recruiting civilian-trained health-care specialists in other areas.

(Ms. Cori Rattelman, (703) 824-2432)

Funding public works

The Navy's public works organizations, which are responsible for the repair and maintenance of facilities and real estate, are funded in one of two ways. At some locations, a public works center (PWC) is paid by customers to do work. At other locations, a public works department (PWD) is given a portion of the base's budget to perform services on request without a charge to the customer. Which approach is more cost-efficient? Our analysis suggests that customer funding makes public works organizations more sensitive to costs and more capable of reducing them.

We examined the Navy's public-private competitions for facility support functions and found several differences between those competed by the customer-funded PWCs and those by the directly budgeted PWDs. First, we found that the initial costs at the customer-funded PWCs tend to come

closer to the best private bids than the costs of the directly budgeted PWDs. Also, during the actual competition, the PWCs tend to bid 22 percent less than the PWDs. Because of their lower bids, the customer-funded PWCs are 20 percent more likely than the directly budgeted PWDs to win the competition and keep the work in house. Finally, we found that directly budgeted PWDs that work for organizations that are customer-funded (such as technical centers) fare better in competitions than other directly budgeted PWDs.

(Dr. Brent Boning, (703) 824-2240)

Military readiness: Meeting the challenge

Managing the readiness of our forces in preparation for major conflicts has always been a challenge. Maintaining readiness today while performing other missions, such as lesser conflicts and operations other than war, is more and more challenging. Many units are either engaged or prepared to engage. This wears down our Servicemembers and wears on the equipment.

CNA's Annual Conference will address a range of issues concerning the readiness of the Armed Forces. We will start by discussing the metrics used to track readiness. We will address how better to identify readiness problems and how best to correct those problems. We will address the nature of many of today's readiness problems. For example, in the drawdown, did the Services cut support more than they cut force structure? Are there structural problems that result in depleting some units and leaving others in fairly good condition? Are there problems in defining priorities, which result in the forces being stretched beyond their capacity? Finally, we will discuss whether the Services can make better use of current resources. Do some policies and practices work against making the best use of resources? Are there imbalances that can be addressed? To the extent that greater budgets are necessary, how much money is needed and how can it be best targeted?

The conference will be held in Arlington, Virginia on 1 and 2 December.

(Dr. Laura Junor, (703) 824-2679)

Three vs. five echelons of maintenance

As a result of emerging concepts of operation and technological advances in ground equipment, the Deputy Chief of Staff for Installations & Logistics, Headquarters, Marine Corps asked CNA to analyze the effect of reducing the Marine Corps' organizational structure for maintaining all ground weapons systems and equipment from five echelons to three.

We focused on four factors related to streamlining maintenance--cost, technology, operations, and implementation--and found that the current way of doing business is no longer affordable, from either a cost or an operational perspective. We recommended a course of action that moves the operationally relevant tasks forward to the operator; consolidates the remaining 2nd EOM tasks with the 3rd EOM at the intermediate level; and outsources the 4th EOM to contractors. We also recommended a sequential implementation with significant testing and experimentation to mitigate operational risk. And, finally, we made recommendations to support the current maintenance system while streamlining occurs.

(Dr. Jim North, (703) 824-2306)

Radiant Diamond demonstration

A dynamic targeting capability is essential to supporting next-generation weapons capable of striking mobile targets, and is key to the planned strike capability of DD-21. Currently, no program is in place to provide a dynamic targeting capability. CNA worked closely during the year with Navy TENCAP, OPNAV (N2), and the National Reconnaissance Office to formalize Radiant Diamond, a demonstration of the feasibility and effectiveness of afloat tactical targeting of real-time, over-the-horizon, GPS-guided munitions. The demonstration led OPNAV (N8) to establish a formal program to support a prototype testbed and continued enhancements for integrating tactical, theater, and national intelligence and sensor sources to support dynamic targeting.

(Dr. Gary Federici, (703) 824-2506)

Recruiting to remain difficult

By 2005 the Military Services' demand for new recruits will be 9 percent higher than it is today. The Services are already having trouble meeting their goals for new enlisted recruits and are concerned that recruiting will only become more difficult in the future. The Navy asked CNA to evaluate the future recruiting market and recommend some actions.

We found that two factors are important to the size of the recruitable population over the next decade: the growth in the youth population and the decline of the veteran population. The Census Bureau projects that the population aged 17 to 26 will grow by 15 percent over the next ten years; this growth should help recruiting. However, the families and friends of veterans, traditionally a rich source for new recruits, will decline; this decline will reduce new recruits by 7 percent. We also examined several other factors whose net effect on recruiting over the next ten years we believe is likely to be small: the changing demographic mix (a higher percentage of minorities), changes in high school graduation and college enrollment rates, and a possible increase in the standard of the Armed Forces Qualification Test (AFQT). We were unable to assess the effect of changes in the civilian economy, drug use, and criminal convictions because reliable long-term forecasts for these factors do not exist; we suggested that the Navy assume no change in these variables for the purposes of long-range recruit planning.

Our overall assessment validated the concern: recruiting will remain difficult and perhaps become slightly more so. Instead of counting on a weaker economy to tip the balance, the Navy should adjust its recruiting effort to changing conditions. Potential actions include paying more to retain personnel, increasing advertising, targeting community college graduates, and resetting AFQT standards.

(Dr. Carol Moore, (703) 824-2260)

Continuing support to carrier operations

CNA continues its support to the Fleet's efforts to achieve the full firepower potential of its aircraft carriers. In work sponsored by NSAWC and coordinated with CCG-7, CVW-9, and USS *Nimitz*, we studied flight-deck operations to identify ways to increase the efficiency of carrier and air-wing assets in generating firepower. We found significant gains could be realized by conducting flight operations continuously at a slightly lower operating tempo instead of operating for only a portion of the day. However, conducting continuous flight operations requires supplementing the manning of key carrier and air-wing billets. One potential source for the additional manpower is the Reserve Component. Currently, we are working with USS *Constellation* and AIRPAC to examine the ability of the Reserves to temporarily augment the carrier and air wing in support of high-intensity operations. In particular, we are exploring ways to modify Reservists' training to ease their integration into carrier operations.

(Dr. Angelyn Jewell, (703) 824-2373)

CNA analysts honored

Two CNA analysts were honored recently in recognition of their work in the field. Mr. John Keefe earned the Department of the Navy's Meritorious Public Service Award for his work at U.S. Pacific Command, where he served as the Deputy Director of PACOM's Command Action Group. The citation highlights the variety of Mr. Keefe's contributions, including refining the articulation of CINCPAC strategy, analyzing the strategic implications of regional trends and developments, and determining future U.S. force requirements in Asia.

Mr. Ken Kennedy was awarded the CJCS Award for Outstanding Public Service for his contributions to USACOM's Theater Missile Defense Initiative. The citation notes that Mr. Kennedy's "ability to structure problems and frame solutions has proven invaluable to the success of USACOM's Joint Force Integration efforts." This award is a first for a CNA employee and one of the first ever awarded by CJCS.