

*C*ONTRIBUTIONS AND *C*APABILITIES



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MESSAGE FROM THE DIRECTOR

The Arroyo Center serves the Army's leadership and its key organizations by analyzing significant policy issues of especial concern. Its strength lies in providing the in-depth research needed to formulate sound options, consistent with its charter as a federally funded research and development center. In the best RAND tradition, Arroyo brings a "systems" view to each problem it tackles.

Like the United States Army it serves, the Arroyo Center focuses on the issues that have dominated post-Cold War military planning. Those issues can be summed up in four challenges, described below. For each challenge, the Arroyo Center aligns its effort along one or more azimuths that should help point the way to potential response.

How should the Army maintain its capacity to carry out its traditional mission—to fight and win the nation's wars—while also responding to the rich variety of other contemporary assignments? During the Cold War, the size and composition of the U.S. military establishment virtually guaranteed a capability to deal with lesser problems (at least, planners could comfort themselves with this assumption). But with the reduction of military forces since 1989, this notion rests on an increasingly shaky foundation. Moreover, the sheer variety of responsibilities given to the military as the preferred instrument of national strategy (from drug interdiction to humanitarian relief to peace efforts in the Balkans) would perplex any force planner, even if the size of the military guaranteed enough capacity to carry out all these missions at once.

The Arroyo Center is analyzing what these responsibilities entail (especially the complex difficulties posed by peace operations), the future force structure the Army might use (especially the one implied by the Army's ambitious program of self-examination, the Army After Next), and the resources that might be required (and their efficient planning and allocation through a revamped Planning, Programming, Budgeting and Evaluation System). It is our increasing conviction that the Army is unlikely ever to have all the specialized capabilities that future assignments might require, in part because the specifics of those missions can now be only dimly per-

ceived. We believe the Army will have to be able to draw from a general set of capabilities, reconfiguring forces quickly and efficiently to meet the specialized requirements of the moment. This has profound implications for the Army's training of its future leaders, and for the uses of its limited investment funds. The Army has already demonstrated a talent for rapid reconfiguration in its preparation of forces for Somalia and Bosnia. Honing such talent, together with further Army investment in necessary command and control equipment, will lay a sound foundation for future joint task forces, especially their leaders.

How can the Army best maintain a viable all-volunteer force as American society changes? The successful transition to an all-volunteer force was one of the most significant military transformations ever. It created a force whose personnel quality is the envy of every other military in the world. But the continued success of the volunteer force is not automatic and cannot be taken for granted, as current recruiting difficulties demonstrate. Indeed, in the post-Cold War era, the Arroyo Center's largest single research component has been manpower and training analysis. The results have benefited both the Army and the general viability of the all-volunteer force.

The Arroyo Center approaches the analysis of manpower issues by emphasizing how an understanding of developments in U.S. society as a whole might influence Army force management. That applies especially to recruiting, which this report discusses in some detail. We believe that solutions to the current recruiting shortfall lie in developing new approaches that respond to changes in our society.

Like the Army itself, we attempt to take a total force approach—hence the large effort devoted to research on the reserves, where the principal issue recently has not been recruiting (although it could soon be), but the training of those recruited, and especially the performance of entire units in carrying out their missions. The last, of course, is a hotly contested question. Arroyo research is attempting to determine what training is actually required to make reserve units effective, and what resources are needed to perform that training.

How can the Army squeeze more bang from each buck? Since their peak in FY85, the funds devoted to defense have effectively been cut by almost 40 percent. The Army's budget is no exception. In the first decade after the Cold War, the Department of Defense coped with the reduction by cutting its structure and by taking what amounted to a procurement holiday. The Army did likewise. But with the need to recapitalize the force in the early 21st century, and with demands for forces in a variety of assignments around the globe threatening to escalate, this budgetary strategy is no longer viable. While it cannot provide the whole amount of funds needed, greater operating efficiency can contribute.

Recognizing this need, over five years ago the Arroyo Center began working with the Army logistics community to develop what has come to be called "Velocity Management." Velocity Management seeks to replace the Cold War logistics concept of "mass" with process improvements—so customers get what they need when they need it because the system is responsive and agile, not because it keeps large stocks on hand "just in case." Such a philosophy's potential to achieve enhancements in readiness, as well as cost savings, is obvious. Velocity Management is an ongoing saga, but we summarize its most recent achievements in this report.

What recapitalization portfolio should the Army pursue? Much of the equipment in the hands of Army units today derives from procurement in the 1980s, based on research and developments carried out in the 1970s. Many items still have much useful life remaining. But the decade or more typically needed to develop and field a major system argues that consideration of the next generation of equipment should begin soon. Moreover, in some cases the future nature of military operations, or how we should approach them, argues for even earlier attention to the Army's recapitalization portfolio.

Indeed, two of the Arroyo Center's most important investment-related efforts are focused specifically on just such issues, namely, digitization of the platforms now in the field, and the development of equipment mixes and forces better suited to rapid force projection.



David Chu (left), Director of the Arroyo Center, and Mr. Paul J. Hoeper, Assistant Secretary of the Army (Acquisition, Logistics and Technology) and co-chair of the Arroyo Center Policy Committee.

Nonetheless, we recognize that major portions of the future investment landscape have yet to be sketched. We are working with the Army to harness the Army After Next process to this key objective, and we are reviewing how best to employ scarce R&D assets to define the future recapitalization portfolio.

Each of these four challenges is pressing in its own right and must be addressed. But they are also likely to resonate for the Army in the externally mandated reviews of national military strategy to come in the next few years. We look forward to working with the Army to produce answers to these challenges.

In this role the Arroyo Center is fortunate in being able to draw on a cross-section of the RAND staff. This report briefly summarizes the credentials of significant contributors to the most recent period of work. Their backgrounds span engineering and the sciences, mathematics and operations research, business, and the social sciences. Almost four out of five have earned the normal "capstone" degree in their fields, and over a third have had active military experience (encompassing all three military departments and both of the major U.S. military conflicts of the last generation).

The other indispensable ingredient in the Arroyo Center's ability to contribute answers to these challenges has been the support of the United States Army, for which we are most grateful. We look forward to the chance to continue to serve, mindful of the Army's historic and prospective role in protecting the nation's interests and in securing a peaceful environment for America and her friends.

1998 ARROYO CENTER POLICY COMMITTEE

The Arroyo Center benefits from the oversight and guidance of an important group of senior Army leaders, known officially as the Arroyo Center Policy Committee (ACPC). Its guidance extends beyond single projects that address issues of immediate concern to the Army to the development of principal lines of research critical to its long-term effectiveness. The ACPC plays an essential role in motivating the Army and the Arroyo Center to initiate research on fundamental policy questions that cut across jurisdictional boundaries within the Army and the overall defense community.



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Contributions

The Arroyo Center's ability to meet the Army's analytic needs is rooted in the depth and breadth of its ongoing research agenda. Combining nonpartisan objectivity with rigorous, quantitative analysis, Arroyo researchers tackle a wide range of the Army's most pressing problems of today and tomorrow. As the following research azimuths illustrate, Arroyo contributions range widely in scope: How is the Army to cope with recruiting problems? What are some ways to speed up the delivery of parts? What can commercial communications do (and what can't they do) for Army command and control? How can the Army carry out peacekeeping operations while remaining ready for major conflicts? The following azimuths touch on these and many other questions, providing the best insights Arroyo Center research has to offer on the major issues confronting the Army today.



Recruiting the Force

Nothing is more important to the Army than the people who fill its ranks. The most technically advanced equipment combined with the most brilliant doctrine will not get the job done without qualified soldiers to operate the weapons and execute the doctrine. Conversely, innovative and dedicated soldiers can overcome a host of shortcomings in equipment or doctrine.

The crucial need for good soldiers is why the current recruiting difficulties pose such a serious problem for the Army. For the first time in a generation, the Army is having major difficulty filling its ranks with the soldiers it needs to carry out the wide range of missions the nation demands of it. Based on current projections, the Army could fall short of its 1999 objective by 5,000 soldiers. RAND and the Arroyo Center have addressed recruiting issues throughout the history of the All-Volunteer Force, and in recent years they have focused specifically on the difficulties confronting military recruiting during the post-Cold War drawdown era.

Gauging the Supply

In the early 1990s, the goal for accessions—new recruits—had been cut below the level necessary to sustain the force. This allowed the services to shrink with the end of the Cold War with-

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out forcing out many soldiers who wanted to stay or paying large sums to induce voluntary separations. But it also meant that the services would face an upswing in accession requirements once the cuts had been achieved. Indeed, recruiting requirements increased sharply in FY96 and again in FY97.

These increased requirements could mean that the supply of recruits might fall short of Army needs. Anticipating this issue, RAND began a preliminary investigation in FY94. It concluded that the enlisted supply should be adequate to meet then-current requirements. Propensity to join the military had declined only modestly from predrawdown levels, and increases in youth unemployment had offset much of the reduction in recruiting resources. In fact, the supply for FY94 was larger relative to requirements than it had been before the drawdown.

Nonetheless, the Army began reporting difficulties with recruiting in the mid-1990s. RAND researchers suggested two possibilities to account for these reports. First, it was possible that a fundamental shift in attitudes had occurred among youth and those who influence them (e.g., parents, teachers) such that the earlier models of enlisted supply were no longer valid. However, given the demonstrated robustness of the prediction models over a long period and a wide range of economic and social conditions, this did not appear to be a likely explanation. The changes in the underlying attitudes of youth would have to be very large indeed to have such an effect, and the evidence did not seem to support the case for such a change. Second and more plausibly, important changes in recruiting resource allocation or management practices could have been the culprit.

Because more work was needed to pinpoint the source of the problems, RAND suggested a hedging strategy to ensure that adequate resources were in place to meet current needs and coming increases in recruiting requirements. Such a strategy included increased advertising and lifting the ceiling on the number of recruiters. An extensive series of RAND studies had shown that advertising and recruiters, together with educational benefits, are the most cost-effective recruiting resources.

In response, the Army and DoD did increase recruiting resources. However, the Army continues to have serious recruiting difficulties. Further, these difficulties have set into motion a chain of events in which recruiters must increase their focus on near-term accessions and the non-high-school market. This focus reduces opportunities to recruit high school seniors and fill the Delayed Entry Program (a pool of enlistees who have signed recruiting contracts in which they agree to enter the Army at some future date, typically after high school graduation). In turn, this reduces the probability of achieving the accession mission in the following year.

After taking a more in-depth look, RAND researchers confirmed that mid-1990s recruiting problems stemmed not from faulty models but from the services' increasing difficulty in

For the first time in a generation, the Army is having major difficulty filling its ranks with the soldiers it needs to carry out the wide range of missions the nation demands of it.

PUBLICATIONS

Beth Asch and Bruce Orvis, *Recent Recruiting Trends and Their Implications: Preliminary Analysis and Policy Recommendations*, MR-549-A/OSD, 1994.

Bruce Orvis, Narayan Sastry, and Laurie McDonald, *Military Recruiting Outlook: Recent Trends in Enlistment Propensity and Conversion of Potential Enlisted Supply*, MR-677-A/OSD, 1996.

Carole Oken and Beth Asch, *Encouraging Recruiter Achievement: A Recent History of Military Recruiter Incentive Programs*, MR-845-OSD/A, 1997.

Rebecca Kilburn, Lawrence Hanser, and Jacob Klerman, *Test Score Trends and Military Recruiting: Estimates from the NELS*, MR-818-OSD/A, 1998.

Michael Murray and Laurie McDonald, *Recent Recruiting Trends and Their Implications for Models of Enlistment Supply*, MR-847-OSD/A, 1999.

Rebecca Kilburn and Jacob Klerman, *Enlistment Decisions in the 1990s: Evidence from Individual-Level Data*, MR-944-OSD/A, 1999.

converting potential supply into actual enlistments. For example, the “marginal productivity” of recruiters dropped: during the 1990s, the number of additional high-quality recruits that could be gained by adding production recruiters declined by as much as one-third relative to the predrawdown period.

Converting the Supply

Why the difficulty in converting potential supply into actual enlistments? The data show some declines in the rate at which youth discuss military service with key influence groups such as family members and friends. However, the reductions matched the decline in propensity, suggesting that this is not an independent problem that the Army must confront. Furthermore, there is no evidence that the advice young people are getting has turned negative. Nor does it appear that recruiters are having difficulty getting access to high school students. Recruiter surveys and the Military Entrance Processing Command’s database on the Armed Services Vocational Aptitude Battery (ASVAB) give no indication of reduced access to students or test scores.

But the data do indicate a difference in the rate of recruiter contacts with high school students and graduates. While the rate of contacts increased for high school graduates, it declined for students. The decline in contacts could stem from the reductions made in recruiters and recruiting stations during the drawdown. It could also relate to a shift in recruiter focus: to meet short-term goals, recruiters could be focusing on high school graduates, who can enter the force immediately, at the expense of high school students, who must wait until graduation. Finally, although recruiters still had good access to ASVAB test scores, the database does show a decline both in the number of schools giving the test and in the number of students taking it at each school. The decline may be attributable to the factors just noted. Whatever the reasons for this decline, the test has traditionally provided leads for recruiters, and fewer students taking the test translates into fewer leads.

Meeting Current and Future Accession Requirements

Prospective Shortfalls

A force reduction of 15,000 soldiers directed as a result of the Quadrennial Defense Review (QDR) lowered the Army’s accession requirements in FY97–98, helping recruiters to minimize shortfalls. But as the economy continues strong and the QDR reduction ends, accession requirements and recruiting problems are growing. The Army entered FY99 with a small Delayed Entry Program and, at this writing, faces a possible shortfall of 5,000 accessions. The shortfall will probably worsen in FY00–01 because these years will have much larger accession requirements.

Recommendations

Based on its intensive examination, RAND recommends that the Army position its recruiting program for the long term, while addressing its near-term difficulties through a combination of traditional and nontraditional steps.

In the near term, we recommend that the Army consider increasing recruiting resources, e.g., recruiters, college benefits, and advertising. However, given lead times for such changes to take effect, even significant resource increases may not be sufficient to offset shortfalls in FY99–01. Thus, to maintain manning levels the Army will probably have to accept more recruits who have lower ability scores or who lack high school diplomas. The Arroyo Center is now helping the Army launch a pilot test, announced by the Secretary of the Army, to screen and accept a limited number of promising, high-ability applicants who lack a traditional high school diploma but complete a structured educational program leading to a high-school equivalency certificate.

The Army should also take near-term steps to work the “demand side” of recruiting. In particular, it should articulate policies to reduce first-term attrition and, perhaps, increase retention. (This latter step would drive up compensation costs because the force would be more senior.)

The larger strategy should refocus the recruiting system for the long term. This refocusing would entail returning recruiters to a less crisis-driven orientation that enables them to concentrate more on recruiting students and building the Delayed Entry Program. Additionally, the Army should work to enhance recruiter production and coverage of the high-quality markets.

Finally, in the longer term it is critically important for the Army to improve its penetration of the college market by proffering different incentives. Recent decades have seen a steady upward trend in the fraction of American youth who attend college; the Army needs to attract more of these young people. Enabling high school seniors to attend college before entering the service, guaranteeing an Associate Arts degree during the first term, or perhaps tailoring enlistment lengths are some ways the Army might gain increased access to the pool of high-quality youth it needs to sustain itself in the future. The Arroyo Center is currently working with the Army to design and test new incentives and programs to penetrate this very-high-quality college market. ■



Readying the Reserve Components

The end of the Cold War and the events surrounding Desert Storm had enormous implications for the Army's Reserve Components (RC). First, because the active force was cut sharply, RC forces became even more important. Not only would major conflicts require substantial force elements from the RC, some of them would be needed far sooner than previous plans had called for. Thus, the pre- and postmobilization training for RC units attracted the attention of planners and analysts alike. They focused both on how the training would be done and on how long it would take.

Second, a decline in Active Component (AC) force size coupled with continued heavy demand for active forces made the "roundout" concept, with its requirement for close and continuous AC involvement, more difficult to support. Furthermore, a smaller active force meant that fewer prior-service soldiers would be available to serve in the RC, possibly exacerbating an already serious problem of low rates of skill qualification.

Finally, the issue of the resources needed to train the RC, particularly following mobilization, looms large. A considerable number of active units were involved in helping the RC prepare to deploy to the Gulf War. Those units are unlikely to be available in any contingency requiring substantial RC forces. Over the last decade, the Arroyo Center has researched all these issues and more.

The improbability of such conditions obtaining in future conflicts, coupled with the likelihood that RC units will be called sooner, suggested the need to improve the readiness of RC units.

Preparing for Operation Desert Storm

Because so many RC units deployed to the Gulf War, a wealth of quantitative data was available on how long it took units to get ready. Arroyo Center researchers combed these data in an effort to answer two questions: what were the essential elements of the postmobilization process, and how long did it take?

The vast majority of RC units mobilized for the Gulf War were support units, such as artillery, transportation, and logistics units. Arroyo researchers analyzed the postmobiliza-

tion process for over 600 support units that went to Desert Storm. They used statistical techniques to determine broadly how a unit's characteristics related to the time it took to arrive at an air or sea port of embarkation. They discovered that three variables significantly affected preparation time: a unit's branch, size (using weight as a proxy), and mode of transportation from the United States to the theater. These variables were then combined in a statistically validated equation that estimates the number of days required to prepare a given type of unit (e.g., days from call-up until being declared ready to deploy).

Units deploying by air go through a five-step process, the first two of which (call-up and personnel preparation for deployment, e.g., wills, powers of attorney) show little variation. The time required for other phases varies by unit weight. A small one might take 11 days and a large one 16. Units traveling by sea have a more complex process because some training takes place while the equipment is in transit, three weeks for most units. A typical sea-transported unit had its equipment at port in 18 days and its personnel validated in 29. Among these units, branch mattered. For example, artillery units required an additional 8 days to get to port.

The case of maneuver units was more difficult to assess during the Gulf War period. Only three maneuver brigades were called, and none deployed. Therefore, we did not have the large empirical database that we had for support units. Instead, at the time, Arroyo Center researchers identified the essential sequence of steps through which maneuver units must pass, and they concluded that there was a wide range of uncertainty about how long it would take (for example, from 78 to 128 days, depending on assumptions). More refined estimates were deferred pending more extensive analysis of training resources and sequences (see the section below on postmobilization training).

Enhancing RC Readiness

By many measures, RC participation in the Gulf War was an exceptional success. However, conditions could hardly have been more favorable: an enemy willing to hunker down and cede the initiative, a unified coalition, a large Army at its peak after more than a decade of acquiring state-of-the-art equipment precisely suited for the terrain and tactics of the enemy, and a demanding training program making soldiers proficient in the use of that equipment. The improbability of such conditions obtaining in future conflicts, coupled with the likelihood that RC units will be called sooner, suggested the need to improve the readiness of RC units.

Premobilization Training

Accordingly, the Army launched a program called “Bold Shift,” an extensive pilot program to boost the readiness of selected high-priority RC units.¹ The Arroyo Center assisted by assessing the contribution that the Bold Shift activities make to readiness.

Arroyo Center researchers found that the Bold Shift program was widely accepted by the units and generally viewed as effective. For example, 90 percent of the leaders thought Bold Shift was effective in preparing units for their wartime missions. Fully 93 percent thought the program should continue in their unit. Furthermore, 90 percent of the leaders rated the AC support as effective.

¹The “Bold Shift” program is a collaborative effort by the active Army, the National Guard, and the U.S. Army Reserve to enhance the readiness of selected high-priority units. It includes heavy involvement by active units in planning and supporting RC unit summer training, lane training, a focus on lower echelon training, and new assessment mechanisms.

These successes notwithstanding, significant problems remained. The most important was that only a minority of the pilot units were able to achieve their premobilization proficiency goals. In the maneuver brigades, for example, fewer than 30 percent of the authorized crews qualified on Table VIII, a qualification course for tank crews. Only about 50 percent of the authorized platoons and sections executed maneuver lanes (a structured training event with a specific focus such as breaching an obstacle) and received satisfactory ratings.

Analysis of the pilot units pinpointed several underlying factors that contributed to the problems. These included low qualification rates in primary military skill (75 percent), many leaders who needed to complete professional education courses to become fully qualified for their current position (37 percent of the E-5s had not completed the Primary Leader Development Course; one-third of the O-3s had not completed the Officer Advanced Course), and a substantial fraction of soldiers who had not attended annual training with their units.

Personnel Readiness

Training was not the only readiness area to draw attention during the call-up for the Gulf War; personnel considerations were also an issue. Many units had to replace soldiers who were not yet skill qualified. Arroyo Center analysis of the personnel records showed that on average, units cross-leveled nearly 20 percent of their enlisted personnel to plug holes created by soldiers who were not qualified in the military occupational specialty (MOS) of their assigned duty position. Analysis also showed that across the units activated for the Gulf War, just 63 percent of the enlisted personnel positions were filled by skill-qualified soldiers. This pattern appeared in all types of units. The remaining positions were either empty (11 percent), filled by soldiers who had not yet completed initial entry training (13 percent), or occupied by soldiers who were qualified in some skill but not the one demanded by the position (13 percent).

Researchers considered a variety of policy measures to ameliorate this problem. The most promising solutions involved strategies to reduce personnel turnover, that is, attrition and job changes among unit members. A major reason for the low qualification rate is that among all the service reserves, the Army RC has the fewest personnel who have served on active duty in the same occupation. In addition, Army RC units have high rates of personnel turnover. Thus it appears that increasing the number of prior-service personnel in the RC and reducing turnover could improve the qualification levels.

However, the researchers found that increasing the prior-service inventory did not go far toward solving the problem. Modeling personnel flows showed that boosting the prior-service content of the RC by 50 percent raised the skill qualification by only three points above the base case projected in the model. This marginal effect occurs for two reasons. First, grade and end-strength constraints require accepting some prior-service personnel in mismatched MOSs in lieu of returning reservists who do not have active experience but are qualified in some MOS. Second, the high rate of turnover in the RC leads to attrition or job changes (and thus a loss of

job experience) among the prior-service personnel. But reducing turnover by 50 percent paid large dividends. Cutting turnover in half raised the skill qualification level by 13 percentage points over the base case. Reducing turnover by 30 percent still garnered about two-thirds to three-quarters of the benefit.

Reducing turnover is no small task, nor is it done cheaply. To accomplish it, Arroyo researchers suggested a menu of options: raising compensation based on time in job, deemphasizing promotion pay increases, and allowing soldiers to hold a higher pay grade than the job carried to remove incentives to change units in search of higher-graded positions. Reenlistment bonuses could be linked to remaining in the same military skill. RAND Arroyo research indicates that the marginal cost of bonuses to reduce job turbulence could be quite modest, ranging from \$200 to \$1,000. However, researchers note that it would be important to implement these bonuses in a controlled setting so their effects could be evaluated systematically.

Postmobilization Training

The premobilization phase of RC training continued to receive considerable attention, not the least of which came from Congress. In 1992, Congress directed the Army to institute a program to increase the active duty support for peacetime training of Army National Guard maneuver and early-deploying units. The so-called Title 7 and 11 legislation dedicated active component support to peacetime RC training, along with some other enhancements.

But postmobilization training was also an issue, particularly in light of the active force reductions made after Desert Storm. Recall that active units were intensely involved in getting RC units, particularly maneuver forces, ready to deploy. In future major conflicts, few if any active units are likely to be available to assist in this task, since active forces themselves will need to deploy quite early. The absence of active support for RC mobilization prompts questions about what resources would be needed, where they would come from, and how long it would take to train units. Resources involved include training sites, trainers, and opposing forces. The Army asked the Arroyo Center to research these questions by focusing on seven National Guard heavy enhanced brigades² that were formed after Desert Storm. Arroyo Center researchers did so and concluded the following:

The absence of active support for RC mobilization prompts questions about what resources would be needed, where they would come from, and how long it would take to train units.

- Adequate resources exist to train up to three brigades simultaneously.
- Training three brigades at once poses some risk that training objectives and timelines will not be met.

²An enhanced brigade is one that is given modern equipment, additional training, and increased personnel in order to increase readiness and combat capability.

-
- Three brigade-level sites (each fed by a gunnery training site) generate three brigades in 102 days and six in 156 days.

The details behind these conclusions are discussed below.

A Training Model

Arroyo Center researchers developed a detailed training model as a way of quantifying the resources—sites, trainers, and so forth—required to train a single heavy brigade and its support elements. They also examined different alternatives for implementing the model, that is, different numbers of sites.

The model contains the training events necessary to prepare a National Guard heavy enhanced brigade to engage in combat shortly after deployment, the most challenging possibility. The model patterns itself on the active force by incorporating the same training that active units undergo in preparing for combat. The most significant influences on training resources are

- The requirements for battalion force-on-force maneuver and brigade-level operations.
- Carrying out the training in the shortest possible time.

The model requires 102 days to execute. It posits a fairly intense field training schedule of about 80 days but also includes time for preparation and maintenance. More capable units could be ready somewhat sooner; less capable ones will require longer. Other, less taxing missions would take less time but would not significantly reduce the resources required.

Assumptions

The model rests on several assumptions, some optimistic, that must be met to produce a brigade trained to enter combat in the time allotted. Key assumptions are that the brigade will be C-1, the highest readiness category, in equipment and personnel within 18 days of mobilization, that it will be at the training levels reached by the better Army National Guard combat brigades during 1992 and 1993, that trainers and opposing force (OPFOR) will be organized and ready to begin training within days of the brigade's arrival at the training site, and that the postmobilization program can be logistically supported.

Results

The alternative that generates enhanced brigades soonest is one with three brigade training sites with three gunnery training sites operating in parallel, the maximum that can be supported. There are some trainer shortfalls, but they are small enough that expedited individual replacement mechanisms could fill the gaps.

Although it is possible to operate three brigade-level sites, the resource bill is substantial, as Table 1 shows. To conduct training at all six sites takes over 26,000 people, some 20,000 of whom must be mobilized from the reserves.

In general, the trainers and training management personnel come from active component sources, such as trainers at the National Training Center (NTC) and active-duty personnel who support RC training during peacetime. Training support, installation augmentation personnel, and about two-thirds of the OPFOR are drawn from reserve component units. The remaining OPFOR comes from the 11th Armored Cavalry Regiment at the NTC.

Operating three brigade sites with three gunnery training sites generates three trained brigades in 102 days and six in 156 days. Operating fewer sites generates trained units more slowly but requires fewer pre- and postmobilization resources and invites less risk. One brigade site at the National Training Center with two company training sites produces the first brigade in 110 days, three brigades in 172 days, and six in 262. Two brigade sites with two gunnery training sites can deliver two brigades in 102 days, four and six brigades in 159 and 226 days respectively. It is not feasible to operate more than three brigade-level sites, because there are not enough personnel available to support training.

Deciding how many sites to operate will require policymakers to make tradeoffs among three factors: risk, resources, and force-generation rates. Risk refers to training quality and timelines. As more sites are staffed, it becomes more difficult to meet the training model's assumptions, the available pool of experienced trainers spreads more thinly across sites, and the quality of training is more likely to decline. Also, as training expertise is stretched across more sites, the opportunity for problems to arise increases. The training model contains little margin for delay, and any significant problems could interrupt the schedule, slowing the force-generation rate. Obviously, the more sites operated, the more resources required, but trained units can be produced faster.

**TABLE 1
PERSONNEL REQUIREMENT FOR THREE BRIGADE AND THREE GUNNERY SITES**

	Active	Reserve	Total
Trainers and training management	2,310		2,310
Training support			
Lanes and ranges	26	688	714
Field support to trainers		198	198
Installation augmentation		7,809	7,809
OPFOR	~4,000	11,372	15,372
Total	6,336	20,067	26,403

Implications

The training model and the resulting resource requirements have a number of implications.

■ The model requires a trained OPFOR, and this requirement has implications for the RC. Our analysis calls for the Army National Guard to meet about two-thirds of this OPFOR requirement, which we believe implies a peacetime mission to train as an OPFOR. A skilled OPFOR is an important part of the model, because it best identifies the weaknesses of the unit being trained and does not divert resources from the training unit. To achieve the necessary level of proficiency, the RC units may require additional training time and additional resources (e.g., equipment, increased active duty training support).

■ If any of the alternatives described is to occur smoothly early in the postmobilization period, considerable peacetime planning and preparation must occur. These activities represent an additional and difficult requirement in light of reduced peacetime resources.

■ The model implies that the training sites will need substantial logistics support—spare parts and ammunition—to sustain the intensive training. These resources will be required at a time when other, higher-priority units are also preparing for deployment. Should the Army not be able to accommodate the surge in demand, the time to train the brigades would lengthen.

■ The peacetime requirements for planning and preparation and training an OPFOR have implications for the traditional view of the cost of reserve forces and the balance of AC and RC force structure. If additional resources are required to ensure the smooth and expeditious mobilization of the enhanced brigades, that increase should be factored into any cost analysis of these units. Lengthening the timeline can substantially reduce the resources required and thus the associated costs.

The Integrated Division

Better ideas for using RC combat forces have continued to engage the attention of defense planners. Based in part on a recommendation by the Commission on Roles and Missions, in 1996 the Army studied the possibility of an integrated division composed of active and RC units. The active component would supply the headquarters, the combat forces would largely come from National Guard enhanced separate brigades, and the support units would be drawn from the National Guard and Army Reserve. Since the vast majority of an integrated division would be drawn from the same National Guard heavy enhanced brigades that the Arroyo Center used in its postmobilization training resource analysis, the Army asked Arroyo to evaluate the postmobilization process for a division composed of these brigades, in terms of timeliness, effectiveness, and cost. Researchers evaluated three postmobilization strategies:

- Train three brigades in parallel at three sites.
- Train all brigade and battalion combat teams at Fort Irwin.
- Train two divisions at two separate sites.

The first strategy sends the division, the major subordinate commands, and one brigade to Fort Irwin. The other two brigades go to Fort Hood and the Yakima Training Area. The second strategy also has the division, major subordinate commands, and one brigade report to Fort Irwin. However, the other two brigades first go to smaller training sites to accomplish company-level training, and then they report in staggered sequence to Fort Irwin, which can accommodate only one brigade combat team at a time for maneuver and live-fire training. The third strategy employs two division training sites coupled with smaller sites for preliminary training. Table 2 shows the minimum time in days required for each strategy to prepare the first and second divisions.

Assessment

Any of the strategies will produce a division capable of carrying out a variety of missions. Thus, no strategy has a dominant advantage. Rather, each has different risks and tradeoffs, giving policymakers a range of options. Arroyo researchers used three criteria to highlight the tradeoffs: force generation, training quality, and resources.

Force generation. Training three brigades in parallel provides a division in the shortest time but carries the greatest risk. Active units deploy from the proposed training sites, and they may not have departed by the time the reserve units arrive. Also, this strategy is the least flexible. If one brigade has substantially lower readiness than the other two, it is not possible to slip it in the mobilization queue to address the problems without affecting the total time required to prepare the division.

The second strategy—all brigades passing through Fort Irwin—takes 53 days longer but poses less risk. All training above company level is done at one site, which houses the bulk of the brigade trainers during peacetime. Only one brigade has to be ready to start training shortly after M-day, leaving time to deal with any readiness problems in the other two brigades.

The third strategy, two division sites, takes longer to produce the first division but delivers the second one almost two months sooner than the second strategy. Its risks parallel those of the first strategy. It has the added advantage of leaving a residual brigade training capability, which could be used to prepare another enhanced separate brigade or an armored cavalry regiment.

Training quality. The second strategy, sending all units through Fort Irwin, offers the best quality. Units would

TABLE 2 • MINIMUM TIME IN DAYS AFTER M-DAY FOR TRAINED DIVISION		
Strategy	First Division	Second Division
Three brigades in parallel	132	217
All brigades at Fort Irwin	185	303
Two division sites	239	239

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benefit from the many quality training facilities of the NTC, including the instrumented battlefield and live-fire ranges. It takes the greatest advantage of the trainer and professional OPFOR experience. The other two strategies require the NTC operations group to divide into as many as three groups, thus diluting the experience. The second and third strategies have the advantage of providing more time for the divisional elements to work together. But both also create long periods of inactivity for elements of the division because the brigades mobilize sequentially, requiring the early brigades to wait for the later ones to complete training.

Resource requirements. It takes more resources to prepare divisions than it does to prepare brigades: about 300–400 more active component trainers, one or two teams from the U.S. Army Training and Doctrine Command's Battle Command Training Program, and simulations and support personnel from the U.S. Army Reserve's Divisions (Exercise). The number varies by strategy.

Conclusions

The analysis leads to two conclusions. First, it takes longer to prepare divisions for deployment than it does separate brigades—at least a month for the first division and two for the second. The additional time is needed for the division-level training. Second, divisions take more training resources than separate brigades, both for pre- and postmobilization training. The Army could get some of these resources by altering current plans, but changes could affect its ability to mobilize and prepare other early-deploying units.

The Future

Arroyo work in the area of RC pre- and postmobilization training continues. Currently, researchers are attempting to quantify the costs and benefits of sending the enhanced National Guard brigades to the Army's combat training centers at Fort Irwin, California, and Fort Polk, Louisiana. It is widely believed that attendance at these centers confers a host of benefits. However, the National Guard brigades go only about once every eight years, and some assert that this training is too infrequent to affect readiness. They suggest doubling the frequency to once every four years. Others claim that attendance is expensive and hurts recruiting and retention. Arroyo Center researchers are in the process of quantifying the effect on the training of the enhanced brigades as well as the impact on personnel readiness, recruiting, and retention. ■



Sustaining the Force

The Army logistics community faces at least four strategic challenges. Stated succinctly, they are to

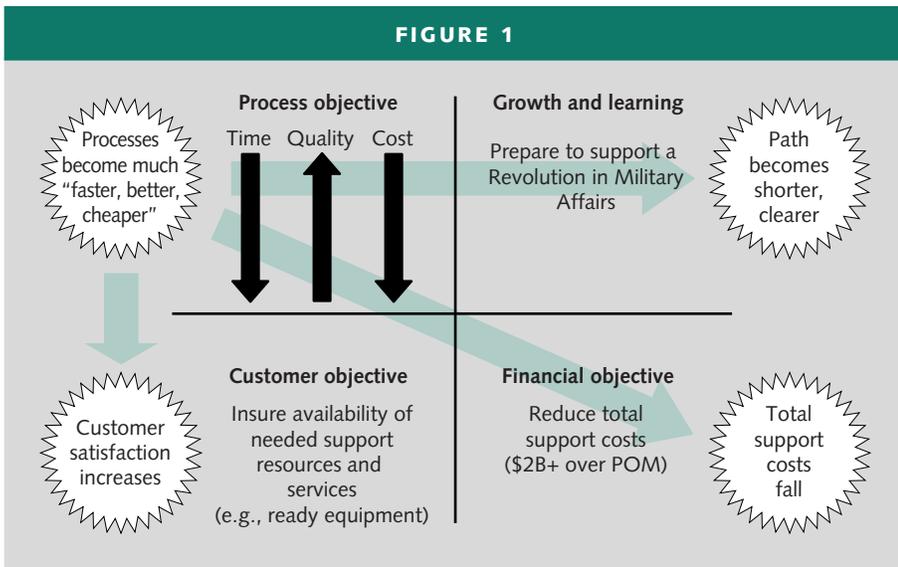
- improve dramatically the performance of current processes
- reduce costs sharply
- develop innovative future support concepts (the Revolution in Military Logistics called for by the Chief of Staff) and
- ensure the continued availability of needed support today.

It is daunting to realize that meeting any of the first three challenges will almost certainly require deep institutional change, beginning now and continuing into the future. Moreover, the second challenge implies that any change must be developed and implemented within the constraint of steadily declining programmed resources, while the fourth implies that no change can be permitted to disrupt current support operations and leave forces at increased risk during a transitional period of implementation. Together, then, these four challenges present a strategic quandary.

The Arroyo Center conducts logistics research intended to help the Army logistics community to escape this quandary, meeting the need for dramatic improvement today and for continuing innovation in the future while reducing costs and avoiding disruption. For the past five years most of this research has been conducted along one azimuth, called Velocity Management. Velocity Management is a term coined by the Arroyo Center and adopted by the Army to describe an approach for dramatically improving the effectiveness and efficiency of key logistics processes and for institutionalizing the enhanced capability to adapt and innovate that will be required to support future forces and operational concepts successfully.

Under Velocity Management, performance improvement is sought on the three dimensions of time, quality, and cost, the aim being to make the logistics system dramatically “faster, better, and cheaper.” Processes targeted by the research to date include the order and ship process, the repair process, stockage determination, the financial management of logistics, and the deployment of logistics capabilities.

Although the process-improvement focus of Velocity Management research appears most obviously pertinent to helping the Army meet the first strategic challenge listed above—improving current performance—in fact it also supports Army efforts to meet the other three challenges. Because Velocity Management strives to make logistics processes not only faster and better but also cheaper, it supports efforts to meet the strategic objective of reducing costs.



Process Improvement Contributes to Other Strategic Objectives as Well

Moreover, process improvement clarifies both the true demand for support and the potential ability of current resources to meet that demand. As a result, the path to a Revolution in Military Logistics becomes clearer and shorter. It also becomes less expensive, by helping the Army avoid the costly mistake of overinvesting in future support resources in an unnecessary attempt to “buy out” today’s performance deficits. Finally, a process-improvement approach ensures that today’s support levels will not degrade during a transition period but rather will continuously improve until dramatic improvement levels are realized. In short, process improve-

ment has been pursued as the preferred azimuth for Arroyo Center logistics research because it provides a strong leverage point from which to drive fundamental needed changes in the Army logistics system (see Figure 1).

Organizing for Innovative Change

Velocity Management research is conducted and managed in ways that are intended to maximize its effectiveness in helping the Army logistics system to implement dramatic change. The research style is highly interactive with the Army, even collaborative. The research not only develops and documents potential improvements to logistics processes, it provides analytic support while those processes are implemented and evaluated. Like other elements of the Army’s Velocity Management initiative, the Velocity Management research in the Arroyo Center is guided by a coalition of senior Army logisticians referred to as the Velocity Group. This group is headed by the logistics Triad of the Deputy Chief of Staff for Logistics, the Commanding General of the Combined Arms Support Command, and the Deputy Commanding General of the Army Materiel Command. The DCSLOG sponsors the Velocity Management research agenda at the Arroyo Center, and the CG CASCOM is the Executive Agent for the implementation of the initiative: Arroyo Center analysts work closely with the Velocity Management cell at CASCOM as well as with the DCSLOG staff and with Army personnel at participating installations, providing analytic support and technical assistance. The analysts also support the Process Improvement Teams that are formed by the Velocity Group to improve specific processes as well as the Site Improvement Teams throughout the Army that are implementing process reforms in the field (see Figure 2).

Successful Outcomes of Velocity Management Research

The Velocity Management initiative has achieved remarkable success in overcoming perennial performance deficits in key Army logistics processes. Reflecting the time-honored definition of logistics as “getting the right thing to the right place at the right time,” the initial focus of the Velocity Group was on improving the Army’s order and ship process. Analyzing data from the Army’s Logistics Intelligence File, RAND Arroyo Center researchers demonstrated that the Army’s order and ship times (OSTs) were extremely long and

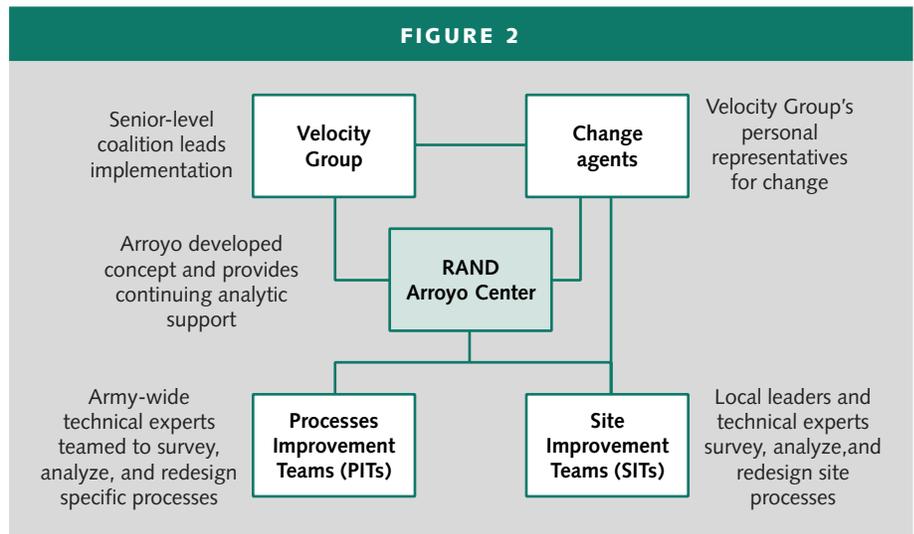
variable. An Order and Ship Process Improvement Team (PIT) was formed, consisting of technical experts representing each segment of the process. Because the order and ship process is complex, the PIT necessarily included representation from non-Army stakeholders such as the Defense Logistics Agency and U.S. Transportation Command.

An Institutionalized Improvement Method

The PIT applied an iterative, three-step process improvement method called D-M-I: Define the process, Measure the process, Improve the process. This is the Army’s analog to the iterative improvement methods employed by leading commercial firms, such as Motorola’s six-step method and Toyota’s four-step method. Defining the process required the PIT members to conduct an end-to-end walkthrough of the process. The walkthrough gave the team a shared and detailed understanding of the process, cleared away misconceptions about how the process was actually performed and how it varied by site, uncovered “low-hanging fruit” in the form of improvements that could be implemented quickly, and supplied the knowledge needed to develop additional improvements. A measurement and reporting system was devised to help diagnose the sources of performance deficits, provide feedback to those implementing changes, and monitor progress.

Reduced Order and Ship Times

Supported by Arroyo Center analyses, the PIT discovered many contributors to the long and highly variable order and ship times. Some of these were easily fixed at the local level and resulted in quick “wins” for the Velocity Management initiative. For example, the batching of requisitions and the batching of materiel at various locations were dramatically reduced. Other



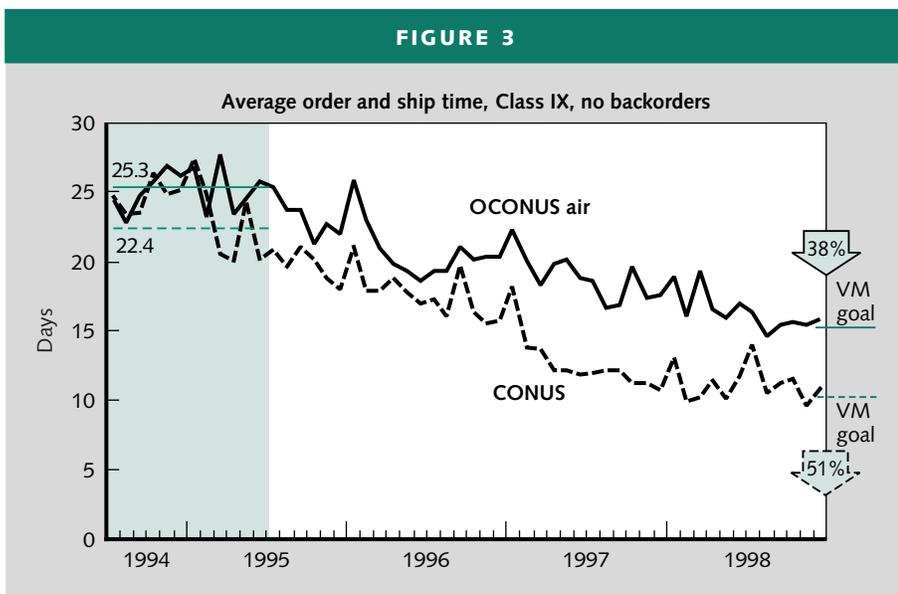
Improvements Are Driven from the Top, Made by Teams, and Guided by Analysis

contributors, however, owe more to systemic issues like financial management processes and require further investigation.

Many process improvements were identified and implemented immediately in each segment of the process, from the ordering of materiel to its receipt. These improvement efforts were always constrained by the principle that improved performance could not be acquired by increasing total costs. As a counterintuitive example, many people believed that greatly increased velocity and accuracy could only be achieved by “flying things via FedEx,” but Arroyo’s research led the Army to move to a “scheduled truck” approach, which is quick and reliable but much less expensive.

The results of the Velocity Management initiative, as illustrated in Figure 3, have been immediate, dramatic, continuous, and enduring. The figure shows average order and ship times for active units in CONUS (lower line) and OCONUS (higher line) that ordered spare parts

(Class IX) from the wholesale supply depots in CONUS.³ Millions of customer orders are represented in the displayed data, including orders from units that are in the field training or deployed as well as in garrison. All priority groups are included, and backorders are excluded. The shaded area on the left represents the baseline period of June 1994 through July 1995, immediately preceding the Army’s formal adoption of the Velocity Management concept. By the end of 1998, CONUS order and ship time had improved by 51 percent compared with the baseline, while OCONUS order and ship time for air shipments (representing about 95 percent of the total OCONUS shipments) had improved by 38 percent.



Air Order and Ship Time for OCONUS Has Improved Nearly as Dramatically as It Has for CONUS

Improved Stockage Performance at Lower Investment

Improvements in one key process lead naturally to improvements in others—if one is prepared to capitalize on the opportunity. The Velocity Group realized that much faster and more reli-

³Although Figure 3 charts average performance for order and ship time, the traditional Army metric, the Velocity Management initiative also employs several new metrics to give improvement teams additional insight into the speed and variability of the process. These new metrics include performance at the 50th (median), 75th, and 95th percentiles.

able order and ship times had immediate positive consequences for the Army's stockage determination and repair processes. Additional PITs were formed to target these processes.

Because order and ship time is the basis for much of the stock held at installations, dramatic improvement in this area enabled the Army to revisit the policies and algorithms that guide stockage computations. It was anticipated that inventory investment levels across the Army could be lowered (by reducing the depth of stocked lines) even while performance was raised (by increasing the breadth of the inventory). In accordance with the D-M-I approach, Arroyo Center analysts proposed a consistent set of metrics for supply performance that permitted the Stockage Determination PIT to measure investment levels in each of the different echelons (wholesale, general support, direct support, and unit) and the performance resulting from those stocks. The proposed metrics measure both the responsiveness of support to customers (fill rate, satisfaction rate, accommodation rate) and inventory mass (e.g., materiel expenditures, operating costs, and deployment constraints). Together, the responsiveness and investment metrics allow the evaluation of alternative approaches for determining the proper size and configuration of stocks at all echelons to meet operational requirements over time, both in garrison and in deployed operations.

With a reporting mechanism for the metrics in place and a waiver from current supply policy granted by the Velocity Group, Arroyo Center analysts worked with supply personnel at Fort Campbell to reconfigure Authorized Stockage Lists to reflect the dramatically improved order and ship time. Like the effort to reduce order and ship time, these steps to improve stockage determination resulted in immediate, dramatic, and ongoing improvements.

Figure 4 shows how the performance of one Supply Support Activity at Fort Campbell steadily improved as its investment level was decreased. In the first phase of the implementation of the improved stockage position, investment levels fell sharply (from \$1.2 million to \$0.4 million) as unneeded stock was identified and returned for credit. Then some of the credit was used to add lines that broadened the Supply Support Activity inventory, improving performance. A third phase promises further improvements in performance. At the last Velocity Group meeting, a second demonstration site, Fort Stewart, was added to validate the new process employed at Fort Campbell.

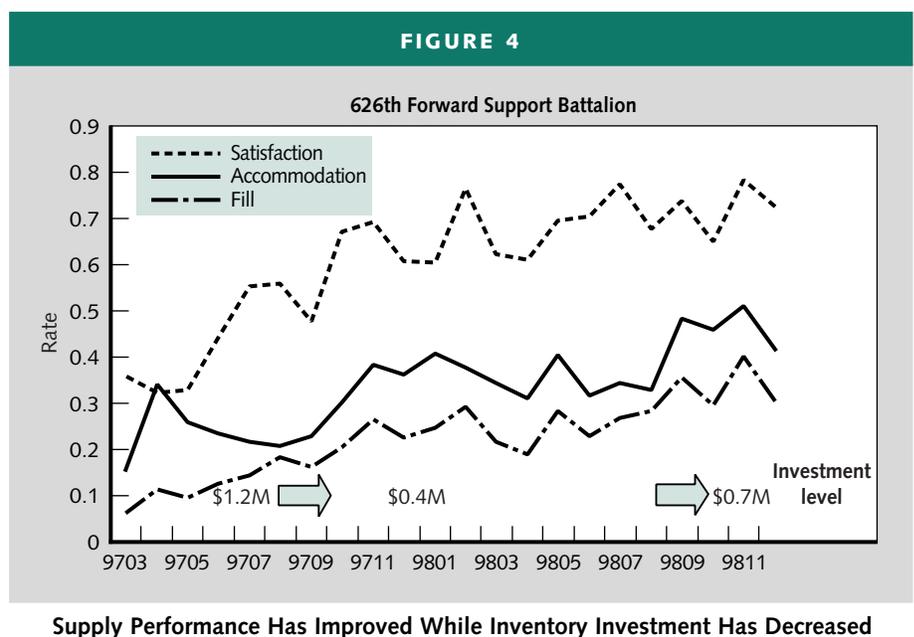
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Reduced Repair Cycle Times

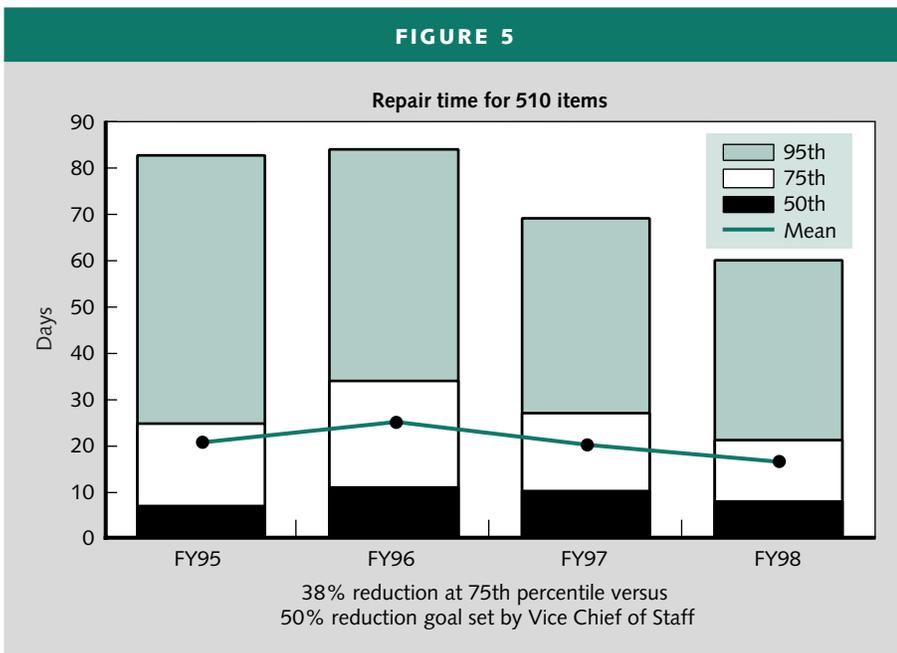
Improved order and ship time and improved responsiveness from local stocks both imply that maintainers will receive the parts they need sooner. This reduction in time awaiting parts should result in reduced repair cycle times and ultimately in improved equipment readiness rates.

The application of Velocity Management to the repair process began by defining the repair cycle for selected weapon systems and component groups and measuring current Army performance. Under Velocity Management, the Army's definition of "repair cycle" not only includes hands-on repair time in the shop but extends from the time an item is reported broken to the time it is repaired and made available for use. Thus, repair cycle time includes time to retrograde material, time to diagnose faults, time awaiting parts or labor, and time for other activities besides just "wrench-turning." All these segments, since they contribute to the total time that a broken item is unavailable for use, were targeted for reduction.

Army data systems are not currently configured to measure the full repair cycle, from "broken to fixed," for most components. However, the Arroyo Center demonstrated that repair cycle time could be measured by combining data elements from a number of data systems. In this way, the research showed that repair cycle time, like order and ship time, was much too long and variable for both components and end items. Faced with this finding, the Vice Chief of Staff proposed the "stretch" goal of reducing repair cycle time by 50 percent.

Through the end of 1998, the Army maintenance community had yet to meet this goal Army-wide; nevertheless, some installations and some shops had made remarkable progress, demonstrating that the goal was not as infeasible as it may first have appeared. For example,

Figure 5 shows that repair cycle time at Fort Campbell has improved steadily since the application of Velocity Management to the repair processes there.



Fort Campbell Has Reduced Repair Cycle Time Dramatically Since FY96

Extending the Velocity Management Research Azimuth

Velocity Management research began as a suite of analyses that focused on improving the performance of current support operations while reducing total support costs, and these studies continue in support of the Army's implementation efforts. As a research azimuth for the Arroyo Center, this work extends beyond the near term and includes studies that explore the far-term implications of a successful Velocity

Management initiative. If the Army succeeds in making its key processes dramatically “faster, better, and cheaper,” that achievement will have implications for the deployment of logistical capabilities, design of the support infrastructure, and development of future support concepts. These are among the topics being explored now in new logistics research in the Arroyo Center. Moreover, as an Army initiative, Velocity Management is helping to institutionalize mechanisms of change—such as cross-functional teaming and the widespread adoption of a common improvement methodology—that will help enable the successful implementation of “revolutionary” support concepts. ■



The Army in Peace Operations

The post-Cold War era has been surprisingly stressful for the U.S. Army. Its early promise of a “new world order” of peace, expanding democracy, and increasing international cooperation has panned out in the broad sense that no regional threat has arisen to replace the Soviet Union’s huge force structure. Likewise, Cold War alliances have not only held together but have been given new purpose. U.S. forces have been reduced in size

But the “new world order” has proved far less orderly than many expected it to be, confronting U.S. policymakers with humanitarian disasters and political instabilities that have been hard to ignore despite their often tenuous connection to core U.S. interests.

commensurately, with active Army divisional and personnel strength shrinking by roughly 40 percent between 1988 and 1998. But the “new world order” has proved far less orderly than many expected it to be, confronting U.S. policymakers with humanitarian disasters and political instabilities that have been hard to ignore despite their often tenuous connection to core U.S. interests. Relatively small portions of the Army’s active and reserve forces have performed very well indeed in Somalia, Haiti, Rwanda, and Bosnia. Yet these so-called military operations other than war (MOOTW) place unique stresses on an Army that must remain prepared to handle two nearly simultaneous major theater wars (MTW).

The Arroyo Center has sought to help the Army come to grips with these stresses in three broad areas. First, it has worked to help the Army and other policymakers anticipate possible instability sooner and understand it better. Second, it has sought to describe MOOTW’s unique military challenges and to develop options to help the Army conduct these operations more effectively. Finally, Arroyo Center researchers have helped the Army understand and deal with the tensions that emerge between the need to remain ready for Desert Storm-like wars with major regional powers while actually conducting operations other than war.

Anticipating Intrastate Conflict

Although policymakers and pundits tend to see military force—especially ground forces—as a last resort, observers and students of intrastate conflict argue that early intervention is often more likely to produce positive results and head off further violence. The intervention may be done with policy instruments other than military forces, or with military representatives “engaging” likely combatants in positive discussion. Whatever the instrument chosen, however, there is a premium on predicting intrastate conflict early and understanding each situation’s unique qualities. The Army’s intelligence community asked the Arroyo Center to help it answer these needs.

In response, Arroyo researchers put together a practical tool—a guidebook and a methodology—to help intelligence analysts determine the long-term potential for ethnically based conflict. Their three-stage model traces the development of ethnic strife, from the conditions prompting an ethnic group’s formation to its mobilization for political action and ultimately to its competition with the state. Since ethnically based tensions often do not lead to violence, the model highlights the special conditions likely to prompt ethnic strife. These include characteristics of both the ethnic group and the state that the group inhabits, suggesting that the resort to violence emerges from the interaction of policies on both sides.

Arroyo researchers have applied the model to four cases to test its validity. Two of the cases were retrospective in character (the breakup of Yugoslavia and the peaceful accommodation in South Africa), and they tended to validate the model’s utility. Two were prospective studies of potential conflict (Saudi Arabia and Ethiopia). As might be imagined, these did not yield clear and concise predictions of whether and when ethnic conflict would break out. But by providing a structured and responsive way of thinking about these conflicts, the model highlighted key factors that intelligence analysts should watch in developing predictions—factors that could also be used by U.S. and allied policymakers seeking to head off a prospective conflict.

Worried perhaps above all by the prospect of ethnic conflict in the Balkans, the Army asked the Arroyo Center to explore the emerging security environment in Eastern Europe and identify its implications for the U.S. Army. Here again, Arroyo Center researchers developed a framework for understanding the potential for ethnic conflict in the former Eastern Europe, including the specific danger areas and the likely types of conflict. Key elements of the framework include the organizational capabilities of the group and the presence of outside backers. The framework helps dispel the notion that ethnic conflicts are irrational and therefore insoluble. This work should help the Army not only anticipate conflict in Eastern Europe and its effects, but also prepare for involvement in it.

Improving Army Performance in Peace Operations

Unlike traditional military operations, MOOTW typically do not have straightforward missions such as seizing a specific piece of terrain. Rather, they ask intervening forces to impose order, feed the hungry, or stabilize conflict zones—fairly complex political-military goals that do not translate easily to clear military missions. To the contrary, military and civilian agencies often find themselves working together, both in the field and within the interagency process in Washington, D.C. For the marriage of political ends and military means to work well in MOOTW, there has to be a supreme amount of communication between the military and political players, down to relatively low levels. Without it, political leaders may act from a misunderstanding of military capabilities, or military planning may proceed from an erroneous interpretation of political goals.

At the highest levels, communication among political and military officials is critical to avoiding, or at least controlling, the problem of “mission creep.” The tendency for the military’s

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Army medical units confront a much wider array of demands in most MOOTW than they do in major wars—demands more like those placed on a community hospital.

mission to expand slowly outward was particularly evident in Somalia in 1993, when what began as a humanitarian relief mission gradually came to focus on reshaping Somalia's politics—with disastrous results. Mission creep falls naturally out of MOOTW's dynamic, quasi-political nature, which makes it difficult to set clear and achievable goals. As some missions are completed, others emerge, usually leading back to the underlying social and political problems that drew U.S. military forces to the scene in the first place. It is especially important for the Army to articulate clearly the capabilities and limitations of its forces, both during Joint Chiefs of Staff deliberations and during the decision processes of the CINCs.

Another source of mission creep, more noticeable in the field at the operational level, stems from the need for coordination between military forces and civilian relief agencies. Arroyo researchers have found that civilian agencies are often unable to follow through with missions they promised to accomplish when the overall operation was planned. For example, some agencies lack funding or training to carry out extensive field operations. Inevitably, these missions fall to the military. Given the difficulty of anticipating these shortfalls, military planners are advised to bring additional supplies and capabilities to handle unexpected missions.

The hierarchical military also can have problems when it tries to interact with a loose collection of civilian agencies over which no single agency head, much less the military itself, exercises complete control. In most MOOTW, Army units and civilian agencies alike have found it useful to create a Civil-Military Operations Center, the civil-military analog to the military's Tactical Operations Center, to coordinate activities. Arroyo researchers suggest that the Army should seek to educate civilian agencies about itself while it in turn learns about civilian agencies it is likely to encounter in the field. One way to do this is to involve these agencies in field exercises.

Arroyo Center research on the challenges facing the Army's medical support units in MOOTW uncovered a range of special demands. Army medical units confront a much wider array of demands in most MOOTW than they do in major wars—demands more like those placed on a community hospital. Soldiers, after all, represent a very narrow range of healthy young adults, but U.S. Army medical units in MOOTW often must deal with a diverse population

of locals, refugees, government employees, and troops of other coalition forces. These groups can easily present a range of conditions not normally seen among U.S. forces and require a concomitantly broader range of services. This may lead to mission creep of a specific nature, as external agencies such as the UN or the State Department urge the Army to expand the medical mission and as Army doctors, compelled by their professional ethics, provide ever greater levels of care. One way to deal with these expansive forces is to consider modular units and special-purpose support packages (e.g., gynecological, geriatric) as an efficient way to

address widely varying demands. Meanwhile, planning and training need to take into account the very different and unpredictable nature of medical challenges in these operations.

A wholly different kind of challenge stems from the extent to which MOOTW tend to call for more combat service support (CSS) elements of the Army than they do combat units. This can make units that deploy to MOOTW remarkably “flat,” with a relatively small combat unit and its commander at the center of a wide array of CSS units. This alone places demands on the commander that are broader than those normally associated with major wars. It also tends to stress CSS troops relatively more within the overall organization. Although Arroyo Center research suggests that virtually all Army occupational groups are being deployed repeatedly to various MOOTW, specific skills like military police or transportation specialists are experiencing high operational tempos.

The situation is further complicated by the fact that many CSS units are lodged in the Reserve Components (RC). In fact, the Army has used RC CSS units almost like active units for MOOTW. They have performed quite well. But many worry that repeated call-ups may ultimately create retention problems in the RC.

Implications for Army Readiness

Perhaps the most serious challenge that MOOTW pose to the Army stems from the need to maintain readiness for MTW even while participating in relatively frequent MOOTW. During the Cold War, MOOTW were seen as “lesser included cases” for an Army geared above all for major war with the Soviet Union. But force reductions since the end of the Cold War have combined with the increased frequency of MOOTW in recent years to call this adage sharply into question. Some observers have even called for the formation of two Armies, a constabulary force for MOOTW and a fighting force for MTW. But the Army is too small at this point to be broken into still smaller elements. Moreover, most research supports the observation of many Army officers involved in MOOTW: soldiers trained in warfighting can acquire peace-keeping (MOOTW) skills, but the reverse is not true. The challenge is to improve the Army’s ability to do both missions.

Arroyo researchers have tackled this broad challenge by first documenting the likely Army force requirements for MOOTW. The results of their work show that MOOTW requirements somewhat exacerbate existing shortfalls in the Army’s desired MTW capabilities. Units such as water-purification teams and truck companies are the ones that typically deploy to MOOTW and are in short supply in the active forces.

The Arroyo Center has also highlighted the extent to which MOOTW actually “consume” more Army force structure than is suggested by the size of the Army force actually deployed to a specific MOOTW. For example, many more people may be involved in an operation than are present in the theater: drawing on data about the Somalia operation, Arroyo researchers found that 3,000 soldiers were in theater in July 1993, but five times that number

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Ronald E. Sortor, *Army Forces for Operations Other Than War*, MR-852-A, 1997.

Jennifer Morrison Taw, David M. Persselin, and Maren Leed, *Meeting Peace Operations’ Requirements While Maintaining MTW Readiness*, MR-921-A, 1998.

Finally, the need to train soldiers to be peacekeepers before they deploy to an MOOTW, and then retrain them in warfighting skills after they return, means that soldiers are unavailable for some months before and after a deployment.

were supporting the operation. Furthermore, cross-leveling, tailoring, and deployment of partial units all reduce the capability of units that remain behind. If part of a unit deploys, for example, those left behind may not have the right mix of equipment and skills to carry out their mission or to train effectively. Finally, the need to train soldiers to be peacekeepers before they deploy to a MOOTW, and then retrain them in warfighting skills after they return, means that soldiers are unavailable for some months before and after a deployment.

Researchers conclude that the Army has enough of most types of units to carry out a limited number of MOOTW and maintain an MTW capability. The shortages are small enough that the Army could buy the needed force structure, but alternatives exist. For example, reviewing the “needed by” dates may show that slipping the schedule a few days will enable a reserve rather than active unit to meet the requirement. However, there is a need to consider the spillover effect of MOOTW on units other than the deployed ones. Unit structure and manning changes need to be considered to mitigate the effects of these operations (e.g., organizing units on a more modular basis so that pulling one element out will not keep the ones that stay behind from training). Furthermore, the RC can play a greater role, although probably not through increased participation in these operations. Rather, they should be looked to for MTW capabilities.

The Army can take some steps that can both improve performance on these operations and mitigate their effects. Greater flexibility could be built into the force structure, enabling units to operate independently. This would involve reorganizing combat support units from functionally specific units to ones with combined capabilities. Other actions include relying more on others (coalition, interagency, private), maintaining warfighting skills by training while on peace operations, and deploying a single set of equipment on the operation and rotating personnel through the one set.

The total Arroyo Center effort to understand the impact of MOOTW upon the Army amounts to more than just a sum of its parts. The various projects serve to link conceptually the interplay among better intelligence preparation for MOOTW, the need for doctrinal changes in MOOTW to accommodate the operational problems they often present, and the total impact upon the Army’s main mission as a result of the demands made by peace operations. ■



Army After Next Wargaming Analyses

The collapse of the Soviet Empire left the United States in a position unique in its history—it had no rival that could pose a fundamental military challenge. The absence of a pressing near-term threat gives the United States the luxury of time to assess its long-term security needs and move deliberately to satisfy them. One way the Army has undertaken this assessment is through the Army After Next (AAN) activity, led by the Army’s Training and Doctrine Command (TRADOC). Initiated in 1996, it links Army XXI—that is, the Army planned for the early 21st century—to a longer-term vision of the Army, ensuring that this vision informs Army research and development requirements. To support AAN analysis, TRADOC initiated an annual series of high-level wargames set in 2020 to 2025. Initially, the games were designed to explore the nature of warfare in the AAN era, emphasizing the political-military aspects of war. But, starting in 1998, emphasis shifted from the strategic to the operational level of war, with the objective of analyzing the effectiveness of newly designed candidate AAN Battle Forces.

The Arroyo Center has assisted TRADOC in a variety of ways. Initially, Arroyo researchers participated in the planning and provided advice about the wargame process, suggesting ways to strengthen it. They have also worked with TRADOC to identify issues for further exploration, many of which challenge commonly held assumptions about what war will be like in the AAN period. Other issues identified pertain to the AAN force itself. Arroyo has been invited to assume even broader roles: leading the analysis efforts and managing the adjudication process.

Wargame Design and Analysis

After the first major wargame (held in January 1997), Arroyo analysts concluded that both the game design and execution could be improved. They recommended several improvements to TRADOC, with an eye to enhancing the analytic rigor of the games. For instance, they recommended that members of the special team (e.g., space) not both give advice to the players and participate in the adjudication, since they would in effect be ruling on their own advice. The team believed that such rigor was necessary to ensure the validity of the issues surfaced. All of the Arroyo game design and execution recommendations were implemented in the second game (held in 1998). This also was the first year of the supporting games, which were designed to explore various aspects of combat in the AAN era, e.g., information operations. The results of the supporting games assist in the adjudication of game moves at the major annual wargame, and this helps improve the utility of the results.

In 1999, Arroyo’s role is expanding to include responsibility for the development and execution of the analysis plan for the major Spring Wargame. This includes leading the identifica-

tion of findings immediately following the game, directing the activities of the TRADOC Analysis Center and Arroyo analysts at the game, and producing the emerging impressions report and the annual report on the 1999 wargame series. The Arroyo Center will also be providing analytic expertise to the supporting games and releasing reports on their results.

As a result of each game, Arroyo identifies issues about the nature of warfare in the AAN time frame as well as issues about the design and effectiveness of the proposed AAN Battle Forces.

Issues About the Nature of War

Strategic issues that challenged assumptions about the nature of war in the AAN era surfaced in many areas, detailed below.

Space

Technological advances have molded the earth's land, sea, and atmosphere into a seamless venue of combat operations. Although each medium has distinct characteristics, specialized vehicles, a unique body of operational concepts based on experience, and its own warriors, the three media are still inseparably intertwined. However, space is not widely thought of today as part of this seamless venue. It provides a home for satellites that supply communications, intelligence, and targeting to military forces and a medium through which intercontinental and theater ballistic missiles pass en route to terrestrial targets. But it has as yet no specialized vehicles for combat in space, and hence no body of operational concepts for space warfare. Space plays a role in terrestrial warfare—an important supporting role—but, today, only that. AAN games have not only offered a glimpse into a possible future where military operations take place in a pervasive earth-space continuum, but also have raised issues of organization, rules of engagement, force design, and the effectiveness of space operations. For example, one side of the wargaming forces relied heavily on space-based assets for communication, targeting, and intelligence, and these capabilities gave it a dominant advantage. However, this dominance led the other side to attack these space assets, severely crippling its opponent's capacity for war, highlighting the need to protect U.S. space-based advantages.

Cyberwar

If space is not yet fully integrated into a seamless web of combat operations, military planners can perceive—at least dimly—its ultimate role. Outer space does not undermine today's assumption that combat operations take place in the “real world.” But the emergence of a “cyberspace” formed by computers and their channels of communication through “hard wires” and the electromagnetic spectrum challenges that assumption. Military planners are only beginning to perceive this “virtual reality” as a new venue for combat. They are aware that cyberwar will in some way influence war in the real world and that war in the real world will in turn affect the reality of cyberspace, but specific characteristics require more analysis.

Nevertheless, in the AAN games, opposing forces (Red) often anticipated that the United States and its partners (Blue) would enjoy an overwhelming advantage in information operations. Therefore, Red tended to allow commanders considerable autonomy at the lowest practical levels. Red issued detailed prewar, mission-type orders, thus permitting commanders to go on “autopilot” and move toward their objectives even when links to the Red national command were broken. This technique minimized the effectiveness of attacks against high-level command and control links.

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Soft Kills

For the most part, today’s military planners rely on explosive blast and shock to damage and destroy enemy targets. In AAN wargames, Red and Blue forces employed a range of weapons with “soft kill” effects including cyberweapons aimed at the programs of an adversary’s computer systems, lasers, and nonlethal chemicals. Both Red and Blue teams used these nontraditional weapons in “stand-alone” operations and in combination with traditional weapons. This use raised fundamental issues about whether certain types of soft kills could be traced to their source and whether they would always constitute acts of war. Blue players tended to regard attacks such as disabling computer systems as less escalatory than those using traditional weapons; i.e., inserting a computer virus might not provoke a response, whereas an attack with an explosive weapon certainly would.

Operations Tempo

The pace of military operations in the AAN period could be much faster than that of today. The early 21st century could come to resemble the strategic nuclear era, in which a President had only minutes to make decisions affecting the fate of the entire nation. Although decisionmakers in the AAN era would have more than minutes, postulated AAN forces could deploy and engage enemy forces at a speed that would leave little time for consultation or consensus building. This highlights the need to ensure that national leaders appreciate how to employ the capabilities yielded by investments in the AAN’s deployment speed and lethality.

Asymmetric Responses

Most contemporary analysis addresses major setpiece military campaigns, in which the forces of one side directly confront those of the other. In AAN games, Red recognized that it could not match Blue’s superior firepower, speed, and situational awareness. Accordingly, it frequently resorted to asymmetric responses. The Red commander employed tactics designed to prevent the AAN Battle Force from attacking Red forces in the open.

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One tactic was to “hide” in the cities, shielding forces with noncombatants (“hugging”). In AAN games, Red forces dashed to undefended cities and then prepared defensive positions. The candidate AAN Battle Forces tested so far have been unsuited for urban operations. Their tilt-rotors and light armored vehicles are vulnerable to enemy fire from concealed locations in buildings. Also, effective concepts for using precision munitions and AAN information systems in cities remain to be developed. Finally, Red guessed that the Blue leaders would not allow an attack when there was a strong likelihood that large numbers of civilians would be harmed. Consequently, Blue normally declined to commit AAN Battle Forces to urban combat. Another Red asymmetric response was to

mount a campaign in the United States that consisted of limited attacks against selected ports of embarkation and other military targets.

Issues Pertaining to the AAN Force

Key issues arising from AAN games challenged some of the planning assumptions about the AAN Battle Force. For the first two years of the AAN project, an air-mechanized Battle Force concept was proposed to comprise about a third of the AAN. The Battle Force could deploy itself using tilt-rotor aircraft. It was deemed capable of rapid insertion into an area of operations to conduct ambush operations because of its superior weapon systems, battlespace knowledge, and rapid mobility. It relied heavily on communications connectivity for navigation and command and control. However, the force was not designed to be decisive; it depended on other forces to gain and hold territory.

Role

The inability of the Battle Force to hold terrain poses several challenges for planners. They need to determine whether AAN forces should have an independent capacity to hold ground, how AAN forces might be coordinated with forces with better ground-holding capabilities, and the extent to which the AAN’s capacity for rapid movement might be constrained by slower movements of Army XXI forces with ground-holding capabilities.

Mission

Given the increasing urbanization of the world, particularly in regions of historically vital interest to the United States, the inability of AAN Battle Forces to deal with urban environments constitutes a substantial handicap. If the AAN is to become a full-spectrum force, it must be able to keep opponents from getting into cities, defeat them in place, or force them out if they go there.

Structure and Capabilities

When an adversary perceives a gross disparity in military capability favoring the United States, that perception should discourage it from going to war. But when war is considered inevitable, a technologically inferior adversary will fall under enormous pressure to find and exploit vulnerabilities in the U.S. force structure rather than confront U.S. strengths directly. The AAN then must be designed to anticipate asymmetric strategies that defy the current conceptions of stylized campaigns.

Many capabilities planned for the AAN Battle Force are shared by “After Next” Air Force and Marine Corps forces. During an early AAN wargame, air-delivered Blue weapons provided the bulk of firepower brought down on Red ground forces. In addition, the AAN offered ground capabilities very similar to those provided by the Marine Corps “After Next” Expeditionary Forces. Should the AAN Battle Force focus on capabilities not provided by the other services?

Basing and Deployment

The basing and deployment of AAN forces requires more thought. Given the proximity of U.S. vital interests to potential adversaries’ territories, permanent CONUS basing may leave the United States vulnerable to an aggressor’s *fait accompli*. Basing overseas is expensive and may leave the force vulnerable to direct attack, but the option strengthens coalitions and assures that substantial forces will be at the scene when war breaks out. The dominant feature of one wargame was the inability of Blue to deploy a decisive force in time. The absence of adequate forward-deployed forces meant that AAN forces had to deploy from the U.S. homeland. Even under the most optimistic assumptions about self-deployment, en route refueling, and debarkation, the AAN Battle Force took several days to arrive, giving the adversary ample time to achieve its limited goals. ■

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Improving Army Planning and Programming: 1995–1999

In the mid-1990s, Army leaders perceived serious problems that undermined the effectiveness of their planning, programming, budgeting and execution system (PPBES) processes.⁴ They perceived that

- They were continuously involved in the “short-sword fight” and unable to focus on long-term plans.
- Decisionmakers were seldom given alternatives to resource allocation issues.
- Army programs were seen as internally focused and divorced from the demands of joint operations.
- Civilian leadership was largely uninvolved in the formative stages of programming.
- Army programs often could not be defended because they lacked both quantifiable standards and convincing analysis.

These perceptions led the Army to request analytical help from the Arroyo Center in reengineering staff planning and programming organizations, processes, and outputs. Arroyo analysis of these problems began in 1995 and continues to the present. This stream of assistance includes complementary studies that helped redesign Army programming processes, developed ways to improve Army planning, and supported the development and institutionalization of the Army Strategic Planning Guidance (ASPG). The Arroyo Center has also helped initiate a new Army Strategic Resource Planning Process (ASRPP), supported the Army staff throughout the 1997 Quadrennial Defense Review (QDR), and provided a basis for thinking about the next major defense review.

Redesigning Army Programming Processes

The first goal was to help the Army reengineer its programming organization and redesign the programming process. To this end, Arroyo proposed a redesigned Program Evaluation Group (PEG) organization, which the Army adopted. The PEGs are important because they help the Army meet the external demands of the various commanders-in-chief while also ensuring that the Army institutional requirements are satisfied. The structure now consists of six broad func-

⁴“Planning” refers to the process of setting objectives and requirements; “programming” allocates resources against the objectives and develops programs to accomplish them; “budgeting” is the process of requesting the funds for the programs; and “execution” is the performance of the programs.

tional PEGs whose responsibilities are drawn from Army statutory requirements: manning, training, equipping, organizing, sustaining, and installations. These six new PEGs—replacing 14—are co-chaired by appropriate members of the Army staff and the Army secretariat. Co-chairmanship increases the responsibility and mutual involvement of the military and civilian staffs in programming. The Arroyo Center also proposed an objective programming framework, “resources-to-objectives,” that assured staff and leadership involvement from the initial stages through final review and approval of objectives and priorities. The resources-to-objectives framework also increases the visibility of PEG resource allocation decisions throughout the programming phase. The Army adopted these improvements in 1996, and it continues to use them, in slightly modified form, today.

Improving Army Planning

With the changes to the programming phase in place, attention turned to the planning phase of Army PPBES. Arroyo researchers worked with the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS) to improve The Army Plan (TAP) by developing a new framework that links Army capabilities to joint operational demands.

This effort, begun in 1996, used a “strategies-to-task” framework that had previously been developed by RAND to identify key operational missions and objectives. Based upon operational demands, the project team, in close coordination with ODCSOPS, developed an eventual set of seven Army mission areas as the major aggregations of required capabilities. The Army then developed and used a hierarchical framework to assess existing and programmed Army capabilities for each of the seven missions with only minor title changes:

- Promote regional stability
- Reduce potential conflicts and threats
- Deter aggression and coercion
- Conduct small-scale contingency operations
- Deploy, fight, and win major theater wars
- Support homeland defense
- Provide domestic support to civil authorities

Reestablishing Army Strategic Planning

In a second step to improve the planning phase of Army PPBES, the Arroyo project team helped reinvigorate Army strategic planning. Beginning in 1997, the team supported the preparation of the ASPG, the first since 1991. The work continues in support of the next planning cycle. The new ASPG has been reoriented to highlight the Army transformation strategy and to give broad planning guidance within the framework of the six Army imperatives of doctrine,

New analytic tools must become a routine part of planning and programming. The Army has a number of such tools, but they are not designed to support decisionmakers in the resource planning process.

force mix, leader development, modern equipment, training, and quality people.

Concurrently, the project team assisted with improving Army planning processes and organizations, including the revision of Army Regulation 11-32, “Army Strategic Planning Process.” For example, the Army Strategic Planning Working Group was designed with a membership that would become the forum for building consensus. The Arroyo Center project team helped Army planners develop and assess alternative courses of action for transforming the Army. Finally, the Arroyo team and Army strategic planners, employing the

RAND-developed “Assumption-Based Planning” technique, identified areas of change that might jeopardize the successful outcome of the transformation strategy.

Developing Strategic Resource Planning

Analytic support is being provided to the ODCSOPS effort to develop alternative modernization programs. This continuing effort considers alternative modernization strategies that support the transformation objectives of the ASPG and focuses on resource requirements to assure a stable long-term modernization program. For example, one effort is examining the effects of acquiring a light-but-lethal armored vehicle sooner.

Supporting Past and Future Defense Reviews

Arroyo analysts provided special assistance, analysis, and simulation support to the Army Staff throughout the 1997 QDR and developed a retrospective “lessons learned” for the Army’s QDR effort to provide insights for future improvements. The lessons point clearly to the need for early and systematic preparation for QDR-like externally directed strategy and resource reviews. Army effectiveness in such reviews would profit from a redesign of the Army Staff to make it better prepared to handle them in stride. This means that leaders should provide strategic guidance, that an appropriately experienced staff should be assembled, and that relevant analytic tools should be acquired. Finally, the Army should undertake selected studies anticipating critical issues expected to arise in future QDR-like activities.

Ensuring Further Success

Even though there has been substantial improvement, further changes will make the Army’s ability to make informed resource allocation choices even better in the future. For example, although the Army’s mission areas have been reorganized into the seven that mirror the DoD’s strategic missions, their internal structure is not as useful as it could be. Their usefulness to decisionmakers would improve if they were organized so that they provided an assessment of

Army operational capabilities over time. As it stands now, the mission areas do not assess requirements to identify needed operational capabilities. Were they organized in this fashion, shortfalls could be identified and addressed in the resourcing process.

Arroyo analysts have recommended further reengineering to improve the effectiveness of the Army staff's response to complex cross-functional issues. The creation of the office of the Assistant Vice Chief of Staff (AVCSA) is an important and necessary first step, but it is not sufficient. The staff is still structured along functional lines that make cross-cutting analysis difficult. A functional organization is useful for some purposes, but to deal with the issues that spread across more than one functional area, additional mechanisms or staffing arrangements are needed.

New analytic tools must become a routine part of planning and programming. The Army has a number of such tools, but they are not designed to support decisionmakers in the resource planning process. They tend to be located outside of the Army staff and, while appropriate for their intended purpose, do not provide the agile and responsive analysis required for making resource decisions, particularly in a fluid environment. Needed, for example, are simulations or spreadsheet models that decisionmakers can draw on as a way of exploring alternative resource approaches.

Perhaps most difficult, the Army must identify ways to reduce Army staff turbulence and provide for long-term development of military and civilian expertise in planning and programming. Today, the average tour length on the Department of Army staff does not permit an officer to see one complete cycle of the PPBES process. Furthermore, owing to internal turbulence, what he or she does see may be limited to the narrow perspective of a single assignment. And given the number of assignments seen as necessary to a rounded career, an officer may only have one tour at the Army headquarters or higher level. Thus, deep expertise in Army-level planning and programming tends to reside in too few officers and lacks a professional development path that will assure future staff expertise. ■

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Digitizing the Army

The Army in the early 1990s realized that society was entering the information age, in which commercial firms were achieving previously unimagined efficiencies by applying information technologies. Senior Army leaders postulated that information technologies applied to warfare would yield similar benefits. However, having just finished buying an array of heavy weapons, they were reluctant to impose radical changes without gaining a clearer vision of the nature of warfare in the information age.

To achieve that clearer vision, the Army began the Force XXI process, a campaign plan of experimentation to develop new doctrine, operational concepts, organizational structures, and equipment. The central concepts underlying Force XXI along with inputs from other services have been adopted in Joint Vision 2010. Attention is currently shifting from the Force XXI process (which has yielded plans for the first digitized corps) to the implementation of Joint Vision 2010 through a joint experimentation process. Many of the Army's lessons learned from its Force XXI process are being applied now in a joint structure.

The Arroyo Center was deeply involved over the last seven years in helping the Army chart the Force XXI path to digitization. These efforts included research in new doctrine, operational concepts and organizations, experimentation, and technology. In addition to research, Arroyo Center staff has been involved in the process of change, both for Force XXI and as the Department of Defense focuses on Joint Vision 2010.

Doctrine, Operational Concepts, and Organization

Early Arroyo Center research conducted for the Commanding General of the U.S. Army Training and Doctrine Command (TRADOC) helped identify and define possible futures for land warfare in the information age. This effort gathered experts in information sciences and military operations to brainstorm the ways that fast-growing communications and computational capabilities might change the nature of conflicts, Army missions, the way the Army organizes, and especially operational concepts. The work yielded six new concepts for Army organization and operations spanning a broad range of issues, from the primary role of the soldier on the battlefield to how the Army, including the Reserve Components, might be organized for its diverse missions. These insights helped set the stage for publication of TRADOC Pamphlet 525-66, *Force XXI Operations*. Additional insights from a follow-on effort were used to describe the benefits of nonhierarchical organizations and the changes required. The researchers concluded that while nonhierarchical organizations do hold promise for commercial applications, adopting them would require changes to the Army's school structure and would greatly complicate joint command relationships that retained traditional structure.

As Force XXI concepts became more defined, the Arroyo Center drew on its long experience at the National Training Center (NTC) to identify and characterize high-performing units training there. Researchers developed a framework to help them understand the nature of high performance at the NTC, and they also applied this framework to high-performance armored divisions in World War II. Results revealed that high-performing NTC units shared characteristics with the best World War II divisions. High-performing units were the ones trained and organized to develop a consistent comprehension of the battlefield, even though that training and organization sometimes departed from stated doctrine and tactics, techniques, and procedures. Accordingly, researchers identified “collaborative workspace environments,” a developmental technology used by commercial industry, as a way to enable training and organization designed to improve battlefield comprehension within units. Collaborative work environments use technology to bring together the elements of a staff so that planning and course-of-action analyses can be performed interactively rather than sequentially.

Follow-on research examined problems that occur when digitized and conventional units operate in a combined force. This work considered not only the impact of technology but also organizational structures and procedures used when units operated next to each other. Using fire support as an example, the researchers argued that as long as basic organizational structures are consistent, diverse units can develop procedures to compensate for technological disparity. Especially for traditional NATO allies, these problems are not insurmountable. However, as the U.S. Army develops new operational concepts and organizations, the problem of digitized/nondigitized force operations will become increasingly severe.

As Force XXI progressed, the Advanced Warfighting Experiments (AWE) associated with it uncovered a number of issues, many of which were not discussed in TRADOC Pamphlet 525-66. At the request of the Army, the Arroyo Center applied Assumption-Based Planning, a tool developed for force planning, to understand the assumptions underlying this publication. The study identified a number of assumptions that must be probed if the goals spelled out in TRADOC Pamphlet 525-66 are to be implemented. The most vulnerable assumptions surround the Army’s role in future military operations other than war (MOOTW), which, under the Force XXI concept, will be addressed by giving trained and disciplined troops sufficient time and training to transition to MOOTW missions.

Experimentation

Drawing lessons about performance characteristics from units at the NTC requires judgment and understanding of context to draw credible observations, because activities there are primarily structured to train units rather than to reflect true combat. As Force XXI progressed, the

As the U.S. Army develops new operational concepts and organizations, the problem of digitized/nondigitized force operations will become increasingly severe.

Arroyo Center used its NTC experience to help derive credible analytic lessons, both from the initial AWE (NTC Rotation 94-07) up to Task Force XXI. We worked with the Army to recommend data collection strategies by observer/controllers, who have experience in judging unit performance, and to develop ways to identify analytic issues that might otherwise be confounded by training requirements.

The Force XXI experimentation process, called Joint Venture, was intended to explore concepts, organizations, and systems. Even though this is not a scientifically rigorous process, it is vital for Joint Venture to have a way to make convincing arguments in support of conclusions. The Arroyo Center helped to develop a framework for tracing decisions to be made to hypotheses, and arguments to experiments. This framework explicitly links needed decisions to experiments, arguing that the Army should focus on the ultimate decisions that must be made (in terms of system acquisition, new operational concepts, or new organizations) and connect these explicitly to experiments that confirm or deny hypotheses. In an effort to develop linkages that will aid decisionmakers, the framework shows a logical progression from decisions required to hypotheses to arguments to experiments. We also show how modeling and simulation, specifically Janus, can be used to explore options and identify key performance parameters for measurement in AWEs. To test it, we applied this framework to the Focused Dispatch and Division XXI AWEs. We demonstrated how experimental results obtained from the AWEs could have been predicted a priori using models and simulations. For example, we showed how allowing calls for indirect fire to be made by every vehicle equipped with an intervehicle information system would increase the number of calls for fire but not necessarily their effectiveness.

Conducting experiments with large system architectures can be complicated and expensive, making it difficult to explore alternatives. RAND has employed exploratory modeling as a way of methodically examining a system to identify its key performance parameters, and the Arroyo Center used this technique to evaluate system architectures. We defined alternative system architectures based on the operational architecture used in Focused Dispatch. Our effort used OPNET, a commercially developed model currently being used at the Army Signal Center and by the Joint Staff J-6 to examine new system architectures. Use of OPNET with analytic approaches such as exploratory modeling was found to be potentially powerful.

Technology and Technology Management

Not all services acquire information systems the same way, and different management approaches could lead to operational incompatibilities. The Army employs the concepts of operational, technical, and system architectures to structure the way it acquires information systems. The Defense Department also follows this approach, and the other services are supposed to use it as well. To determine how consistent the approaches are, the Deputy Chief of Staff for Operations and Plans (DCSOPS) and the Director of Information Systems for Command, Control, Communications, and Computers (DISC4) asked the Arroyo Center to review the

plans and management approaches of the other services and to compare them with the Army. We found a number of disparities among the services that could result in operational problems. For instance, the services approach digitization differently, with the Army and Marine Corps centralizing management and control of planning and the Navy and Air Force taking a more decentralized approach. While all of the services aim at achieving the standards of the Joint Technical Architecture, the diverse approaches can result in near-term interoperability problems. We conclude that the Army and Marine Corps approach facilitates early identification and resolution of problems. Current research along these lines reinforces the need to develop a clear *operational* architecture before proceeding to develop a *system* architecture. This research is continuing with an emphasis on interoperability with NATO.

Because key Force XXI concepts have paralleled developments in society and commercial industry, it is natural to assume that commercial information technologies would carry over to use by the military. In many respects, however, the military's situation differs from commercial industry and will require investments to develop capabilities unique to the Army. At TRADOC's request, the Arroyo Center developed and applied a framework for understanding how communications technologies meet operational requirements, and we showed how commercial communications technologies will probably not meet the Army's operational needs for the tactical battlefield. We recommend specific investments in research and development to fill gaps in capability. Our recommendations include areas of new system components (more rugged and less susceptible to electronic countermeasures than commercial components), wave forms and signal processing (support to mobile users and communications infrastructure), and networking technologies (needed for networking protocols to support Army mobility and deployability needs). These findings are important both for Force XXI and Army After Next. These results have been briefed widely both within the Army and to the Department of Defense.

The Assistant Secretary of the Army for Acquisition, Logistics, and Technology and TRADOC are currently sponsoring research examining how the Army can exploit new and developing information technologies. This research is focused on the next generation of technologies, which build beyond the Force XXI concepts of information sharing toward networked information systems. These technologies, as shown in commercial industry, open opportunities for organizational change. Relevant commercial applications of technologies have enabled the formation of virtual organizations and underlying communications networks. These organizational structures have improved effectiveness and efficiency. The concepts could be tailored to apply to the Army's unique operating environment. This research is continuing, with the aim of identifying key investments that the Army should make to leverage commercial developments in networking, software, and protocols.

Process

The Arroyo Center has participated directly in three processes the Army has used to incorpo-

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James Dewar, Jeffrey Isaacson, and Maren Leed, *Assumption-Based Planning and Force XXI*, DB-172-A, 1997.

Leland Joe and Phillip M. Feldman, *Fundamental Research Policy for the Digital Battlefield*, DB-245-A, 1998.

rate information technologies into its operations: the Army's Analysis, Experimentation and Planning Group (AEPG), the Army Science Board, and an American Institute of Aeronautics and Astronautics (AIAA) technical committee.

The APEG consisted of the Army's senior analysts from analysis and test and evaluation and formed a senior steering group to oversee the analysis portion of Joint Venture. The AEPG was chaired by the Technical Advisor to the DCSOPS, and the Director of the Arroyo Center had been a member from the group's inception.

Arroyo Center researchers also participate in the Army Science Board and chaired a special issue group that studied the methodology used in the AWE. They identified a number of ways to improve the analysis process of AWEs. Their recommendations included the need for more coherence in the Army's analytic community as it supported AWEs, which recommendation was met with formation of the AEPG, better definition of AWE hypotheses to support decisions, and more disciplined configuration control of AWEs to focus experiments on key capabilities and systems.

Finally, Arroyo Center researchers are currently participating in a study by the AIAA technical committee on information and C2 systems. This committee has been chartered by the Deputy Under Secretary of Defense for Advanced Technology to develop a code of best practices for joint experimentation. This committee is drawing heavily on Army experiences and lessons learned to help the joint community and U.S. Atlantic Command in the joint experimentation process. ■



Improving Rapid-Reaction Forces

One of the most important areas of research for the Army (and for all the services for that matter) has been the development of rapid-reaction capabilities to deal with fast-breaking contingencies. A growing number of concepts revolve around the idea that small, mobile forces can get into action quickly, employ sophisticated surveillance and targeting systems to gain a comprehensive view of the battlefield, and then call in annihilating fire from organic ground weapons or from more distant ground, naval, or air systems. Over the last five years and in the course of several different efforts, a multidisciplinary Arroyo Center research team has used high-resolution simulation and other tools to explore operational concepts and technologies for these types of forces.

This avenue of work began as Arroyo Center researchers supplied direction and long-term analytic support to the Rapid Force Projection Initiative. The RFPI is a multiyear advanced concept technology demonstration tasked to develop and demonstrate quick reaction force concepts, including equipment, such as the EFOG-M, that could be left with early-entry forces. Beginning in 1993, the Arroyo Center team formulated several key operational concepts that underpinned the RFPI demonstration, including the focus on hunter/standoff killer systems (e.g., linking forward-emplaced sensor arrays to precision indirect fire systems such as EFOG-M and HIMARS). Using demanding scenarios ranging from Southwest Asia’s flat and open plains to Eastern Europe’s hills, ravines, and forests, the work quantitatively showed the importance of providing sufficient coverage by sensors employing different detection modes, linking them through efficient, agile, and robust command and control networks, and matching weapon characteristics to timelines and targets. Comparisons of precision indirect fire systems for anti-armor and counterbattery missions also highlighted the relative effectiveness of man-in-the-loop weapons and submunitions that could cover relatively large areas.

In related studies on the importance of future Army long-range fires, the simulation team built on the RFPI work to provide insights into how ground-based deep fire systems might complement other precision munitions. This work also helped the Army leadership make critical decisions about continuing one of its earliest smart munitions programs, the sense and destroy armor (SADARM) system, which was compared with alternative munitions (e.g., the Air Force’s sensor-fused weapon), other Army systems (e.g., the brilliant anti-armor submunition and Damocles), and other emerging concepts and technologies. Researchers recommended the use of SADARM with cannon systems but not with the less accurate missiles.

The 1996 Defense Science Board summer study extended the light forces work by examining more distant future concepts (i.e., 15–20 years) for rapid-reaction forces augmented by long-range and remote fires. A quick-response Arroyo study for the DSB examined options in a mixed-terrain scenario and yielded several surprising results: (1) providing comprehensive intelligence without improving existing weapons enhanced force effectiveness only marginally, (2) long-range, air-delivered smart munitions may not be able to engage targets as decisively as organic weapons, especially if the enemy employs countermeasures, and (3) assuming they were delivered, even smart munitions had diminishing marginal returns in mixed terrain—that is, kills-per-munition drop off precipitously after initial attrition of the enemy. As the time increases between detection and arrival of the munition, efficiency falls off dramatically. Instead, a mix of organic and long-range, remote weapons provided a robust and cost-effective approach to making light forces lethal and survivable.

As these efforts expanded in scale and scope, the Janus-based combat simulation used by the Arroyo team also

A mix of organic and long-range, remote weapons provided a robust and cost-effective approach to making light forces lethal and survivable.

PUBLICATIONS

John Matsumura et al., *The Army After Next: New Concepts and Technologies for Light Battle Forces*, DB-258-A, 1999.

Randall Steeb et al., *Joint Operations Superiority in the 21st Century: Analytic Support to the 1998 Defense Science Board*, DB-260-A/OSD, forthcoming.

John Matsumura et al., *Rapid Force Projection Technologies: Assessing the Performance of Advanced Ground Sensors*, DB-262-A/OSD, forthcoming.

John Matsumura et al., *Analytic Support to the Defense Science Board: Tactics and Technology for 21st Century Military Superiority*, DB-198-A, 1997.

Randall Steeb et al., *Rapid Force Projection Technologies: A Quick-Look Analysis of Advanced Light Indirect Fire Systems*, DB-169-A/OSD, 1996.

Randall Steeb et al., *Rapid Force Projection: Exploring New Technology Concepts for Light Airborne Forces*, DB-168-A/OSD, 1996.

Randall Steeb et al., *Light Forces—Heavy Responsibilities: The Role of Technology in Enabling Future U.S. Early Entry Forces to Fight and Survive*, MR-473-ARPA, 1995.

evolved. The size of the digital terrain area expanded, force levels went from brigade to division, and postprocessing was added to enable researchers to track events from sensing to endgame. Special models of acoustic sensing phenomena, command and control dynamics, smart munitions, reduced signatures, and aircraft survivability were produced, tested, and integrated. This improvement process is continuing with the projected incorporation of a newly developed model of an advanced protection system for armed vehicles and the possible integration of elements of the Joint Conflict and Tactical Simulation. This module is now being readied for release by Lawrence Livermore and is intended to simulate operations on urban terrain, probably the most difficult environment for combat modeling.

A major recent thrust is the Army After Next (AAN) initiative. The Arroyo team was initially asked in 1996 to explore light and “air mechanized” concepts being considered for AAN. The team participated in AAN tactical and operational wargames, modeled specific systems, and evaluated their performance. This work has grown to integrate assessments not only of concepts but also underlying, enabling technologies. The work extends the earlier RFPI and DSB light force efforts by examining medium-weight options such as 15-ton armored vehicles with associated tactical lifters, and it pushes the time horizon out to 25–30 years. The project is evaluating such issues as the survivability of the lifters and ground vehicles when they penetrate deep into enemy territory, the effectiveness of various indirect and direct fire options, and the importance to the force of agile maneuver. The continuing Arroyo analytic support effort has influenced the direction of the AAN program, particularly with respect to insights provided about the viability of the air mechanized concept. Recently, new options for air mobile and air assault forces have been proposed in the AAN initiative, in part due to the Arroyo finding of airlifter vulnerability in deep insertion operations.

In the summer of 1998, the Arroyo team was again asked to provide analytic support to the Defense Science Board. Here, the focus was on evaluating joint operational concepts as might have been idealized in Joint Vision 2010. Building the work on AAN, RFPI, and related new work on military operations on urbanized terrain, the team used a demanding East European scenario to explore the joint force concepts. Unlike Desert Storm, which largely took the form of a combined-arms counteroffensive, this situation posited a range of formidable quick-reaction capabilities that would be used to help stop an invasion as it was happening. The findings challenged some of the conventional wisdom about the future. For example, it found that long-range surface and air fires, equipped with future smart and brilliant munitions, could not successfully carry out the mission alone, even with comprehensive surveillance and target acquisition and fast command and control (among other highly optimistic assumptions). The work also demonstrated that against a clever opponent using cover, responsive organic weapons are efficient and capable, and that small ambush teams can be more lethal and survivable than traditional consolidated maneuver forces. ■



Improving the Army's Science and Technology Capability

The U.S. military enjoys a large and, arguably, growing technological edge over any likely opponent. This superiority is crucial not only because of the advantage it confers over any present-day opponent but also because it stands at the center of the Army After Next (AAN) concept. However, this advantage is by no means assured, and the Army's science and technology capability is critical to sustaining it. Here, the outlook is less bright. Research and development (R&D) budgets have fallen sharply, and there has been a concomitant reduction in the Army's civilian workers, including its scientific and technical experts. For the past several years, the Arroyo Center has investigated how the Army can maintain its technological edge in the face of these developments.

Arroyo has focused primarily on four areas: (1) enhancing the Army's capability to generate technologies, (2) managing the R&D portfolio, (3) expanding the number of suppliers that support the Army with advanced technologies, and (4) improving the quality and capability of the Army's science and engineering workforce.

Generating New Technologies

To generate new technologies, the Army needs to maintain a "smart buyer" capability, that is, a cadre of technically capable Army civilians—scientists and engineers—who can match their counterparts in industry when dealing with the technical issues involved in R&D and procuring new weapon systems. This smart-buyer function will be crucial to realizing the technology-intensive AAN.

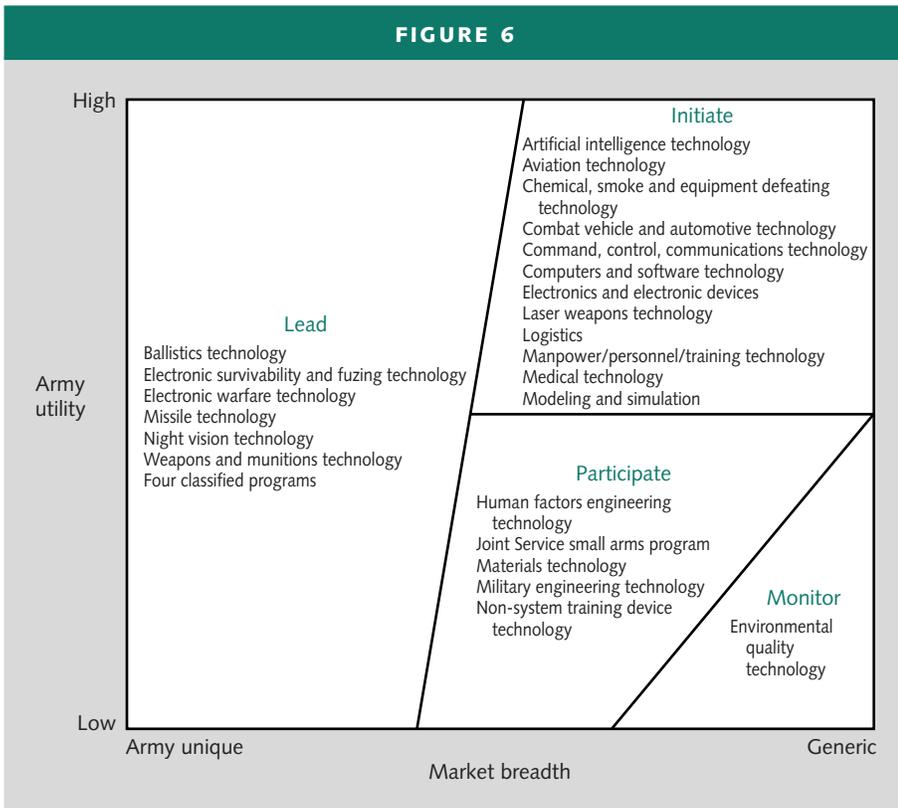
A comprehensive survey of Army acquisition workforce personnel, interviews with representatives from industry and former government officials, and a review of past literature show that the best way to achieve a smart-buyer capability is through collaborative research efforts. Wide exposure to technology developments outside the Army is key to honing smart-buyer tools. The Army can get this outside exposure by collaborating with other military laboratories, academic institutions, and industry.

Managing the Army R&D Portfolio

Managing DoD research and development has always been a challenge, and it is even more difficult today. Defense R&D managers have limited resources to spend on pursuing new technologies, and there is an active civil and commercial market for some technologies that interest

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FIGURE 6



Categorization of Basic Research Technology

the Army. Which areas must the Army pursue on its own, and which are best pursued in collaboration with organizations outside the Defense Department?

In support of the Army Materiel Command, the Arroyo Center has formulated an approach for managing R&D portfolios that can help resolve this dilemma. Army managers must understand how their R&D efforts are allocated and how they might more efficiently manage them to take advantage of scarce resources and technological capabilities elsewhere. The framework for managing technology developments depends on two dimensions—how useful the technology is to the Army and how widely it appeals to the broad market—and four technology management approaches within the framework: lead, initiate, participate, and monitor (see Figure 6).

Different acquisition reform initiatives are appropriate for each technology management approach. When we map Army R&D activities listed in the Science and Technology (S&T) budget against the four technology management approaches, we find a number of potential opportunities to increase communications and awareness through collaborative efforts with industry. In some cases, collaborations are under way. For example, the government of Orange County, Florida, is using Army-generated computer simulations to aid in disaster relief. And there are other likely candidates on which the Army is planning to spend significant resources. For example, there could be potential collaborations in modeling and simulation with companies such as Walt Disney and Warner Brothers. Materials research might find interested collaborators in such companies as DuPont and Minnesota Mining and Manufacturing. Communications and awareness developed by such collaborations would be important to maintaining an Army smart-buyer capability.

Clearly the Army must take the lead on technologies of critical importance to the AAN that have little or no wider commercial market value. Weapons and munitions technology come readily to mind. However, other technologies equally important to fielding an AAN—artificial intelligence and computers, for example—have wide commercial appeal. For these the Army might only need to initiate research or participate in it with commercial firms.

Expanding Suppliers

The Army has to expand its base of suppliers to include more commercial firms. These firms are key because they are the leaders in many technology areas that interest the Army. In the past, leading-edge firms have not wanted to work for the military because of the onerous and myriad rules, regulations, and practices (e.g., the Federal Acquisition Regulation and Defense Acquisition Regulation Supplement). The interviews we conducted with Silicon Valley high-technology firms showed that none of the companies would do research with the Army under the current contractual instruments in place that require abiding by the FAR/DFARS regulations.

However, we also learned that new contractual instruments, a result of acquisition reform, can mitigate the bureaucratic rules, regulations, and practices. For example, “Other Transactions” (OTs), a new type of contracting instrument, are much more flexible than more traditional types of contracts governed by the FAR. They essentially eliminate all cumbersome administrative regulations and permit the use of commercial accounting practices. They are also much more flexible in dealing with such issues as intellectual property. All but one of the firms we talked with would consider doing research with the Army if OTs were used.

OTs potentially offer the benefit of cost sharing. Our interviews with commercial companies suggest that these firms are not averse to sharing research costs if the partner brings something of technology significance to the collaboration. The implications for the Army are significant. For example, approximately one-third of the Science and Technology budget falls in research areas where collaborative efforts with industry are possible. Because the potential cost savings to the Army are large, Arroyo Center has recommended that OTs be required for all S&T efforts where collaborative efforts are possible.

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Improving the S&T Workforce

Our findings also show that the Army laboratories are facing serious science and engineering personnel problems. Such problems include attracting new scientists and engineers, retaining and developing the most skilled ones already on board, and eliminating subpar performers. Although new reforms will solve some of the most pressing problems and are clearly an important first step, they will not be sufficient. Our assessment of the approximately 50 personnel reform initiatives and demonstrations shows that they should be able to solve many of the concerns related to training, developing, and separating civilian personnel, but they will be less effective with the concerns related to acquiring and sustaining personnel. This is because some of the problems are linked directly to the Civil Service system (e.g., difficulties in enforcing

PUBLICATIONS

Kenneth Horn et al., *Performing Collaborative Research with Nontraditional Military Suppliers*, MR-830-A, 1997.

Kenneth Horn et al., "Performing Collaborative Research with Nontraditional Suppliers," *Army RD&A*, November–December 1997, pp. 39–41.

Carolyn Wong, *An Analysis of Collaborative Research Opportunities in the Army*, MR-675-A, 1998.

Carolyn Wong et al., "An Approach for Efficiently Managing DoD Research and Development Portfolios," *Acquisition Review Quarterly*, Vol. 5, No. 4, Fall 1998, pp. 339–356.

Ike Y. Chang et al., *Use of Public-Private Partnerships to Meet Future Army Needs*, MR-997-A, 1999.

involuntary separations) or to current domestic economics (e.g., fierce competitiveness for available scientists and engineers), neither of which can be easily altered.

The Army must consider alternative measures to augment the personnel reforms. These measures are consistent with the acquisition reform initiatives available for Army use. They include greater reliance on temporary employees and co-located contractors, organizational realignments that provide closer interaction with materiel and concept developers, and modified laboratory constructs (such as a DARPA-like model or more government owned/contractor operated laboratories).

To make progress in the four areas and to realize the full benefit of reform initiatives, however, the Army will have to break down some cultural barriers and stereotyped perceptions that impede the use of opportunities afforded by acquisition reform. For example, cultural barriers are in the way of the exploitation of cost-sharing and leveraging opportunities with industry. The key to removing them is education and training. Arroyo has recommended that the Army consider putting together a "road show" similar to those conducted as part of the effort to educate commercial firms about military specifications and integrated product teams. The effort should discuss the various acquisition reform initiatives that are available and indicate how they can be constructed and executed to facilitate cost sharing and leveraging.

Continuing Work

Work on these issues continues. The Army has asked the Arroyo Center to refine its analysis of the "smart buyer" capability to determine when serious problems may crop up in the acquisition process because of a shortfall in this area. It has also asked us to determine how industry maintains its capabilities during periods of reduction and to explore contracting for functions rather than performing them in-house. We are also continuing our work on collaborating with industry, with an eye to identifying likely candidates for Army-industry collaborations or partnerships and to charting a path that will make successful collaborations more likely. Finally, we are applying our technology management framework to quantify the amount of the Army's science and technology budget that could be shared with other services, government agencies, or industry. ■

A major goal of the Arroyo Center is to inform the public policy debate with the results of its research. One of the ways it accomplishes that goal is through a variety of written reports, briefings, and short issue papers. Publications released to the public in 1998–1999 are described below. Copies of these publications and others listed herein are available from RAND Distribution Services (Internet: order@rand.org; Telephone: 310-451-7002; FAX: 310-451-6915). Abstracts of RAND documents can be viewed on the World Wide Web (<http://www.rand.org>).

Allocating Scholarships for Army ROTC
Charles A. Goldman, Michael G. Mattock
MR-1069-A

In the face of rising tuition costs and the increased importance of scholarships to meeting its commission mission, the Army designed a new scholarship program, known as the tiered scholarship program because it offered four different scholarship values (called tiers). Under the new program, enrollments at public colleges increased modestly and the Army controlled the total scholarship cost. But as feared, many fewer of the nation's most academically able students enrolled in ROTC, and the programs at the nation's most prestigious private colleges and universities were facing the prospect of closure. Based on these findings, the authors recommended and the Army implemented a high-value scholarship targeted to some prestigious private colleges. The study also analyzes several complete scholarship programs to replace the tiered scholarships. The analysis supports plans that continue to offer high-value scholarships at some prestigious private schools, while offering lower values at other schools. Although it would entail some significant tradeoffs, the authors have also presented a plan that would offer greater values to in-state students at public schools—a large potential market, especially if tuition increases in the private schools do not abate in the decade ahead. These offers would require congressional approval because the law currently prohibits the use of scholarships for room and board, which constitute the largest portion of these in-state students' expenses to attend college.

Consolidating Active and Reserve Component Training Infrastructure
John F. Schank et al.
MR-1012-A

This report examines ways to consolidate training infrastructure and augment capabilities across components to gain efficiency and achieve economies of scale in conducting individual training of Active Component (AC) and Reserve Component (RC) soldiers. Results suggest that permitting AC and RC students to take courses at the nearest accredited school has both economic benefits (i.e., reductions in travel, per diem, and potential instructor costs) and morale or cultural benefits (reductions in the time AC students spend away from their homes and units, lower training workloads for AC instructors, and more interaction, potentially building trust and confidence across components). Such interaction could also benefit functional areas beyond maintenance, such as combat service support.

Denying the Widow-Maker: Summary of Proceedings, RAND-DBBL Conference on Military Operations on Urbanized Terrain
Russell W. Glenn et al.
CF-143-A

This document compiles the views presented and issues debated during a two-day conference on military operations on urbanized terrain held in February 1998. Conference atten-

dees agreed that a continued reliance on World War II–type combat methods for operations in cities was counterproductive. They recognized that near-term improvements in future force readiness to conduct military operations in cities would be limited to enhancing current procedures via modified doctrine, training, and extant or proven concept technologies and that such changes could marginally improve force readiness. For the longer term, alternatives to large-scale commitments of U.S. manpower into urban areas and subsequent engagement of adversaries at close range were deemed desirable.

Emerging Commercial Mobile Wireless Technology and Standards: Suitable for the Army?

Phillip M. Feldman
MR-960-A

The U.S. Army, as well as the other services, is moving in the direction of greater use of commercial technology and standards to reduce costs and increase interoperability. This report assesses the suitability of certain technologies—including components and subsystems, physical layer standards, protocol standards, and products and services—for Army tactical applications and suggests the appropriate mix of commercial, military-unique, and military variants of commercial systems for use on the digital battlefield. The author recommends specific Army research and development areas where progress is needed to address voids between military requirements and currently available and emerging technology.

Engaging the Mexican Military: Challenges for the U.S. Military

Kevin F. McCarthy, Kevin M. O'Connell, David F. Ronfeldt
DB-248-A

Mexico is currently in the throes of a structural transformation that threatens its traditional political and social order and the government's ability to pursue its program of political and economic reform. Mexico's current president has expanded the traditional duties of the Mexican military in the hopes that this will buy time for his reforms to work. This situation creates problems for the U.S. Army's efforts to engage the Mexican military. This documented briefing explores the roots of the current situation and the challenges it poses for the U.S.

military. It offers a range of scenarios for future consideration together with possible responses for the U.S. military. This analysis suggests that since it has few options for influencing its Mexican counterparts, the U.S. military should proceed with caution in any such attempts.



Enlistment Decisions in the 1990s: Evidence from Individual-Level Data
M. Rebecca Kilburn, Jacob A. Klerman
MR-944-OSD/A

This work updates previous estimates of individual enlistment models, investigating the relationship between family, individual, local labor market, and other background characteristics and the decision to enlist. The study makes

three primary innovations to earlier models. First, it uses data from the early 1990s, while the most recent estimates were from the early 1980s. The data report the enlistment behavior of a cohort of individuals from the National Educational Longitudinal Study (NELS) who were high school seniors in 1992. In general, the authors find that their coefficient estimates are similar to those estimated by earlier models, while the mean levels of the explanatory variables are more often significantly different from those in earlier data. Second, the authors explore the utility of including some additional variables in the model that are more relevant to the 1990s or were not available in early data. These include measures of immigrant status, criminal behavior, drug use, in-state college tuition, and whether parents were in the military. The research finds that immigrant status, criminal behavior, and having parents in the military are significant determinants of individual enlistment decisions. Third, the authors estimate the individual enlistment decision as a three-choice decision—whether to enlist, enroll in college, or work after high school graduation—in contrast to earlier studies, which modeled the enlistment decisions as a two-way choice of whether to enlist or not. The study concludes that the trivariate-choice model dominates the bivariate model because it produces more sig-

nificant coefficient estimates and yields more insights into the reasons that individuals enlist rather than choosing alternative activities.

Facilitating Effective Reform in Army Acquisition

James N. Dertouzos et al.

DB-233-A

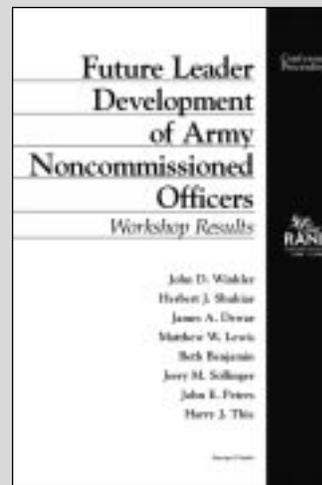
This documented briefing examines both the acceptance and progress of current acquisition reform efforts and the factors affecting support for these efforts within the Army's acquisition work force. In general, beliefs about how eliminating military specifications and standards affect product quality, life-cycle costs, and current program costs were found to be the most important predictor of whether or not a worker "supported" the elimination. Support is also strong for greater use of integrated product teams within the acquisition process, although there is much room for improvement in implementing them. Finally, greater cooperation—in the form of "partnerships"—with industry is supported within the acquisition work force. However, the full use of partnerships has been hampered by significant organizational and process barriers that can only be overcome through other reform efforts as well as the refinement of existing contractor certification processes.

Fundamental Research Policy for the Digital Battlefield

Leland Joe, Phillip Feldman

DB-245-A

The Department of Defense is looking to commercial information technologies to meet its needs for digitization equipment. The commercial marketplace has shown responsiveness and agility in meeting the growing civilian demands for robust, reliable, and ubiquitous communications. Many of these technologies are of direct use or can be built on to develop systems for the military. This study examines the ability of the commercial marketplace to meet the future needs of the Army, and it identifies research areas for Army investment. The authors find that commercial wireless systems will not meet the Army's future needs, and that the Army needs to trade off requirements with future investments in research and Army-unique systems.



Future Leader Development of Army Noncommissioned Officers: Workshop Results

John D. Winkler et al.

CF-138-A

This document presents the proceedings and results of two workshops held to assess the current NCO leader development system and develop a "vision" of where the NCO corps wishes to head. In addition, it identifies policy issues that

emerged from these workshops. Workshop participants found that the leadership development system was fundamentally sound, with only selected areas requiring improvement: the self-development component of the Noncommissioned Officer Education System (NCOES), the incentives for noncommissioned officer education, and the timing and rigor of the institutional instruction. The document also identifies some research implications of the workshops. Two areas needing additional analysis are the self-development component of the NCOES and the alignment between enlisted personnel management policy and professional development.

Futures Intelligence: Assessing Intelligence Support to Three Army Long-Range Planning Communities

John E. Peters, Eric V. Larson, James A. Dewar

MR-995-A

This report examines the intelligence needs of three groups of Army long-range planners—strategic, force developers, and acquisition—and considers the potential of Army intelligence to satisfy these needs. The authors recommend specific actions by the Office of the Deputy Chief of Staff for Intelligence to address Army intelligence's main shortcomings in supporting long-range planning. Sustained interaction of Army intelligence experts with their customers will improve the quality of support. Communications technology plays a role here, but the more important task is to make sure that Army intelligence continues to develop high-quality experts with sound reputations among Army planners and in the intelligence field.

Improving the Army Planning, Programming, Budgeting, And Execution System (PPBES): The Programming Phase
Leslie Lewis, Roger Allen Brown, John Schrader
MR-934-A

As part of a special assistance activity for the Director of the U.S. Army's Program Analysis and Evaluation Directorate (PA&E), the Arroyo Center participated in creating a new program development process and methodology. The principal objective in this work was to improve the Army's Program Objective Memorandum (POM) development process. The improvements were designed to (1) enhance the Army's ability to view the totality of its resources, (2) improve its resource decision process, and (3) justify those choices within the Army and to the external community, including the Office of the Secretary of Defense, the Chairman of the Joint Chiefs of Staff, and the Congress.

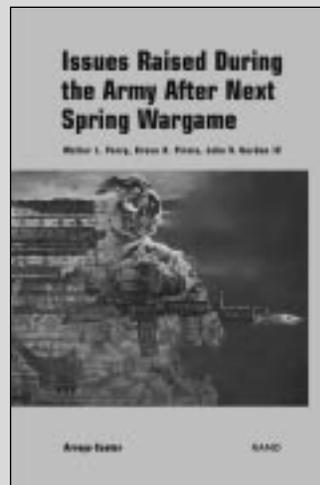
Information-Related Operations in Smaller-Scale Contingencies
Stephen T. Hosmer
DB-214-A

This documented briefing summarizes the findings of a study of U.S. intelligence, OPSEC/deception/C2-neutralization, public affairs, and psychological operations, particularly as they pertain to U.S. ground force operations in smaller-scale contingencies. The study analyzes the conduct and effectiveness of information-related operations in past U.S. interventions; examines the potential impact of the information revolution on future U.S. lesser-conflict operations; and offers recommendations for U.S. military commanders and civilian decisionmakers. These recommendations concern the organizing, training, and equipping of U.S. forces as well as the planning and conduct of intervention operations.

Issues from the 1997 Army After Next Winter Wargame
Walter L. Perry, Marc D. Millot
MR-988-A

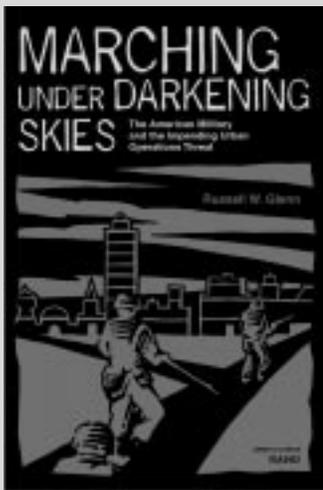
Army After Next (AAN) was designed to link Force XXI to a long-term vision of the Army and to ensure that this vision informs Army research and development efforts. As part of the AAN process, TRADOC is conducting a series of high-level

wargames to identify and explore issues affecting the development of the Army in the next century. The Arroyo Center is assisting TRADOC by providing a framework to evaluate AAN, identifying issues to explore in the wargames, helping to manage the wargame data collection, and assessing game results. This report addresses the design of the Winter Wargame, suggests improvements for its execution, and discusses the role of the wargame process in a broader AAN analysis.



Issues Raised During the 1998 Army After Next Spring Wargame
Walter L. Perry, Bruce R. Pirnie, John Gordon IV
MR-1023-A

The Army After Next (AAN) wargames provide a structured forum for discussion of national security issues associated with the nature of warfare in the early-to-mid 21st century. This report summarizes issues generated during the AAN Spring Wargame 1998. The wargame was set in 2021. The major game activity involved an attack by Red on the states on the south shore of the Persian Gulf. The United States was also involved in a multinational peacekeeping operation in Indonesia. In addition, continuing border conflict between India and Pakistan escalated dangerously during the game, eventually resulting in nuclear weapon use. These three separate events were designed to examine the role of AAN forces in global conflicts. Five dominant themes cut across the twelve issues identified in this study: rapid deployment into theater, asymmetric responses, urban warfare, homeland defense, and information operations.



Marching Under Darkening Skies: The American Military and the Impending Urban Operations Threat
Russell W. Glenn
MR-1007-A

This report draws on a review of relevant literature, service doctrine, training, and emerging technologies to assess U.S. Army preparedness to undertake military operations on urbanized terrain (MOUT). It concludes with a number of observations and preliminary recommendations that also apply to the nation's other armed services and unified commands:

(1) the four services should adopt Marine Corps Warfighting Publication 3-35.3 as the initial foundation for a more comprehensive doctrine on joint MOUT; (2) the U.S. Army Center for Lessons Learned should publish a MOUT lessons-learned bulletin; (3) realistic consideration of operations in urban environments should be a part of service and joint exercises; (4) MOUT considerations should help inform the development of new technologies; (5) MOUT facilities should be made available for training in addition to their use by organizations during formal rotations at Combat Training Centers; and (6) complete instrumentation should be provided for selected Combat Training Center MOUT facilities.

McGregor Renewal and the Current Air Defense Mission
David Rubenson et al.
MR-1010-A

This report evaluates the military rationale for the 600,000-acre McGregor Range on Fort Bliss. The authors find that an apparent low use is an artifact of Army range record keeping. Although it is moderately utilized, McGregor is a critical factor in ensuring that Fort Bliss can perform its role as the nation's center for air defense. The authors also find no obstacles to civilian uses of McGregor in conjunction with existing military missions. White Sands Missile Range does have sufficient land and airspace to accommodate the McGregor mission, but transferring activities could occur only in the context

of a national evaluation of military basing options and policy. The study concludes that there would be adverse military impacts in returning McGregor to the public domain, but few positive changes in the level of nonmilitary use.

Microworld Simulations for Command and Control Training of Theater Logistics and Support Staffs: A Curriculum Strategy
John R. Bondanella et al.
MR-929-A

This report discusses changes in training structure, content, and methods, with the focus on developing training for CSS staffs operating as staffs, not for individual training. The document discusses shortcomings of the current approach to CSS staff training and then proposes a process-oriented approach. It illustrates how microworld models can be used to train CSS processes. It goes on to describe how pilot testing of prototype models shows this approach to be feasible for large unit staffs. It concludes with a proposed training strategy that the authors believe is more appropriate and useful for meeting the challenges posed to the Army by personnel turbulence, split-based operations, increased reliance on information, and decreased training resources.

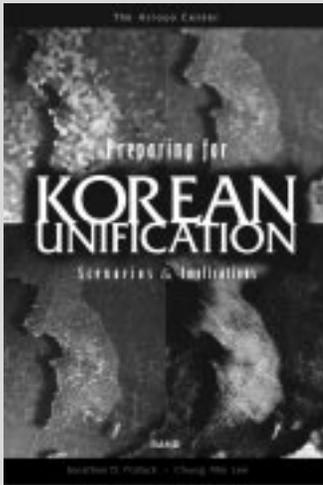
Personnel Turbulence: The Policy Determinants of Permanent Change of Station Moves
William M. Hix et al.
MR-938-A

Moving soldiers between permanent duty stations in the future will remain as prevalent as it was before the downsizing that followed the collapse of the Soviet Union. To reduce movement rates substantially, the proportion of the force serving overseas would have to be reduced or lengths of service would have to be dramatically increased. The first of these policy changes lies outside the Army's authority to change; any savings associated with the second would be offset by substantial incremental costs to provide the financial incentives for soldiers to serve longer.

Predicting Military Innovation

Jeffrey A. Isaacson, Christopher Layne, John Arquilla
DB-242-A

Although military technology is increasingly available and affordable, not all countries have the capacity to improve their military effectiveness by acquiring hardware. Integrative difficulties—in command structures, doctrine and tactics, training, and support—are common in the developing world, and many states will have to find some level of innovation to overcome such difficulties if they are to use military technologies effectively. This documented briefing describes a research effort aimed at understanding and predicting how militaries may improve their battlefield effectiveness. It first analyzes military innovation conceptually and then formulates a framework for predicting the likelihood of innovative success. The research synthesizes a broad literature on innovation and provides a useful tool for assessing future military developments.



Preparing for Korean Unification: Scenarios and Implications

Jonathan D. Pollack and
Chung Min Lee
MR-1040-A

The authors examine four alternative scenarios that would result in the unification of the Korean peninsula. They describe the defining characteristics of each scenario, potential indicators that would predict

specific outcomes, some possible variations in paths to unification, and some operational implications for the U.S. Army under different conditions and circumstances. The four scenarios (peaceful unification, collapse and absorption, unification through conflict, and disequilibrium and external intervention) highlight both the increasing vulnerabilities of the North Korean state and the substantial uncertainties that attach to each outcome and to the potential U.S. policy responses. These considerations impose major conceptual, policy, and operational challenges both in the near and middle term and in the postunification peninsular security environ-

ment. Each warrants an enhanced analysis and assessment effort, lest U.S. and ROK policymakers find themselves ill prepared for major challenges to alliance management and to the U.S. Army role in a future crisis.

Recent Recruiting Trends and Their Implications for Models of Enlistment Supply

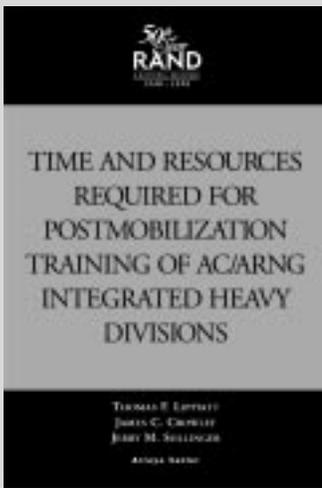
Michael P. Murray, Laurie L. McDonald
MR-847-OSD/A

The authors estimate an econometric model of high-quality enlistment supply using geographically disaggregated data from two periods, FY83–87 and FY90–93. They find that econometric models based on data from the earlier period do not predict the recruiting difficulties reported by the military in the 1990s. This finding conforms to a preliminary assessment done by the Arroyo Center and reported in 1994. The authors also find that econometric models estimated with the 1990s data give altered counsel about the effects of at least some policy variables, most notably the need for more recruiters or recruiting resources.

Staffing Army ROTC at Colleges and Universities: Alternatives for Reducing the Use of Active-Duty Soldiers

Charles A. Goldman et al.
MR-992-A

The increased tempo and range of military operations coupled with reduced manning levels are exerting pressure on the Army for optimal use of active-duty soldiers. Consequently, the Army is seeking opportunities to fill positions now occupied by active-duty soldiers with other personnel. This report discusses alternatives to current Senior Reserve Officer Training Corps battalion staffing in which many active-duty soldiers performing teaching or training functions would be replaced by reservists or by contracted civilians with former military service. Also, civilians would be contracted to help cover administrative and logistics functions now performed by active-duty soldiers. The authors recommend testing two alternative staffing plans, each over a period of two years. One plan focuses on former military personnel, the other on reservists. Preliminary estimates suggest that savings could be as high as 700–900 active-duty soldiers.



Time and Resources Required for Postmobilization Training of AC/ARNG Integrated Heavy Divisions
Thomas F. Lippiatt, James C. Crowley, Jerry M. Sollinger
MR-910-A

This report analyzes the postmobilization training process for integrated divisions composed of elements of the ARNG and the Active Component. It considers two of three concepts the

Army proposed: three enhanced separate ARNG brigades organized to deploy either as a standard Army of Excellence division or as three separate brigades; units organized to deploy only as a standard division. The study analyzed three ways of carrying out the postmobilization training: (1) training three brigade combat teams in parallel at three sites; (2) conducting all brigade combat team and battalion task force maneuver training at Fort Irwin; and (3) operating two division sites. The study assesses the three options from three perspectives: force generation, training quality, and resources. Any of the three approaches produces trained divisions. But the time for producing the divisions varies from 132 days to 239 days, and each poses different risks and tradeoffs.

The Use of Microworld Simulations to Train Theater-Level CSS Staffs: Training Development Considerations
Emile Ettedgui, David Oaks, John D. Bondanella
DB-265-A

The authors discuss a microworld simulation modeling approach that can facilitate changes in structure and content for training combat service support (CSS) staffs operating as staffs, not individuals. The briefing illustrates how microworld models can be used to train CSS processes. The discussion includes an overview of how these models operate and what the prototypes are intended to illustrate in a training curriculum. The authors conclude with some general lessons learned from developing and testing these prototype models with an actual training audience, and they suggest how training developers may proceed to redesign mission training plans for higher-level theater CSS command-and-control staffs.

Use of Public-Private Partnerships to Meet Future Army Needs
Ike Y. Chang et al.
MR-997-A

The Arroyo Center was asked to assist Army Materiel Command by creating a strategy for managing the development of advanced technologies, with special attention to the changing future environment for research and development. In previous phases of this project, researchers showed that the Army has significant opportunities to do collaborative research with industry. Moreover, they documented new concepts the Army can use to implement a collaborative policy and showed how effective those concepts would be in attracting nontraditional suppliers. This report expands on the notion of a collaborative research strategy and discusses the utility of public-private partnerships in the management and development of Army infrastructure, intellectual property, and financial arrangements.

"...we band of brothers": The Call for Joint Urban Operations Doctrine
Russell W. Glenn
DB-270-JS/A

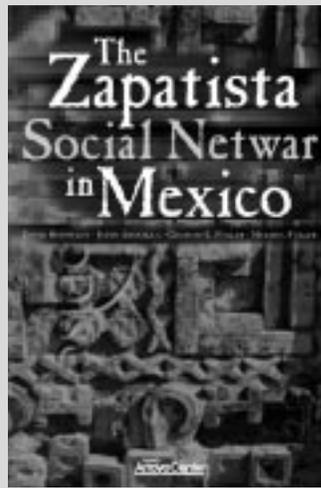
Recent historical events and changing world demographics have caused the U.S. military to recognize shortfalls in its urban operations doctrine. This document summarizes a RAND study carried out to identify requirements in this area. The first phase of the study determined the current status of joint urban operations doctrine. The second phase identified and described the character such a doctrine should take. The third and final phase compiled specific requirements that literature reviews and extensive field interviews dictated should be part of a U.S. joint MOUT (military operations on urbanized terrain) doctrine. The author concludes that urban operations doctrine is needed and that it should be in the form of a separate joint publication. The Joint Doctrine Working Party subsequently directed that work begin on the new Joint Publication 3-06 (JP 3-06), *Doctrine for Joint Urban Operations*.

Western Europe, 1979–2009: A View from the United States

Robert A. Levine

MR-1000-OSD/A/AF

As the start of the European Monetary Union (EMU) approaches, Western Europe may be heading for troubles that could extend to the United States. The problem lies in the West European political and economic system, which currently faces high unemployment and other harsh realities. If Maastricht's rigid macroeconomic constraints are relaxed—if EMU balances its stress on inflation control and fiscal rectitude with equal emphasis on employment and growth—then rising unemployment may be reversed in the short run and conditions can be set for long-run improvement. If not, and if unemployment remains near or above 12 percent, then the worst is yet to come. What will happen to EMU will depend on the futures of the four key West European political economies: Germany, France, Italy, and the United Kingdom. The author derives four scenarios, ranging from a worst case to “a way out.”



The Zapatista “Social Netwar” in Mexico

David Ronfeldt et al.

MR-994-A

The information revolution is leading to the rise of network forms of organization in which small, previously isolated groups can communicate, link up, and conduct coordinated joint actions as never before. This in turn is leading to a new mode of conflict—“netwar”—in which the protagonists depend on using network forms of organization, doctrine, strategy, and technology. The Zapatista movement in Mexico is a seminal case of this. What began as a violent insurgency in an isolated region changed into a nonviolent though no less disruptive “social netwar” that engaged the attention of activists from far and wide and had nationwide and foreign repercussions for Mexico. This study examines the rise of this social netwar, the information-age behaviors that characterize it (e.g., extensive use of the Internet), its effects on the Mexican military, and its implications both for Mexico's stability and for the future occurrence of social netwars elsewhere around the world.

Capabilities

ARROYO CENTER RESEARCHERS

To provide the broad range of expertise needed to address fully the Army's near- and long-term challenges, the Arroyo Center has assembled a unique corps of researchers, notable not only for their individual skills, but also for the richness of their combined multidisciplinary perspective. Scientists and engineers, mathematicians and computer gurus, and social scientists across many disciplines—many with practical military experience, including a range of conflicts—analyze the Army's most complex problems and provide objective solutions where other more narrowly focused approaches might fail. Certainly the Army's investment in this unique Arroyo capability will continue to return value in today's and tomorrow's defense environments. Our people, along with their educational background and areas of military training and technical expertise, are listed below.

John Bondanella (Logistics and logistics training, installation operations, intelligence operations)
M.B.A., Management Science (Operations Research), Tulane University
Active duty military experience: Intelligence and operations analysis at corps and Department of the Army

Pat Boren (Data analysis for Army and Marine Corps logistics studies)
B.A., Communications Studies, University of California, Los Angeles

Marygail Brauner (Effects of financial management policies on the Army logistics system)
Ph.D., Electrical Engineering/Operations Research, University of California, Los Angeles

Roger Brown (Organizations and force structure design; resource allocation strategies)
M.S., Mathematics, Rensselaer Polytechnic Institute
Active duty military experience: Commanded field artillery units at all levels through brigade; general staff responsibilities at Department of the Army

James Crowley (Army readiness and training readiness)
M.S., Educational Psychology, Georgia State University
Active duty military experience: Army commander, operational and training staff

Jim Dewar (Strategic planning and planning methodologies)
Ph.D., Mathematics, University of Southern California

Patricia Dey (Army training and manpower issues for the active and reserve forces)
B.A., Mathematics, Mount St. Mary's College

John Dumond (Applying best business processes to improve military logistics)
Ph.D., Business (Operations Management), Indiana University
Active duty military experience: operational and staff assignments that included logistics, operations and acquisition at all levels of the Air Force

Rick Eden (Military logistics)
Ph.D., English Language and Literature, University of California, Los Angeles

John Folkeson (Logistics support, weapon system management, maintenance manpower)
Ph.D., Business, University of Houston
Active duty military experience: Air Force logistics assignments at squadron and wing level, faculty at Air Force Institute of Technology, and analytic work at Department of the Air Force

Ken Girardini (Logistics, information technology, modeling)
Ph.D., Electrical Engineering, University of California, Los Angeles

Russell Glenn (Enhancement of U.S. capability for military operations in cities; soldier performance under fire)
Ph.D., American History, University of Kansas
Active duty military experience: Chief of Plans and Exercises during Operation Desert Storm, FM 100-5 author

Charles Goldman (Economics of education, including institutional strategy and competition, supply and demand for Ph.D.s, financial aid, and trends in enrollment and financing)
Ph.D., Economic Analysis and Policy, Graduate School of Business, Stanford University



Clockwise from top left:

Arroyo researcher Charles Goldman reviews trends in education financing and enrollment with RAND Army Fellow LTC Donna Kapinus and staff member Kathy Rosenblatt.

Marygail Brauner reviews the effects of financial management policies on the Army logistics system with members of the U.S. Army CASCOM.

John Bondanella discusses Army logistics with CW4 Al Herrero.

John Dumond, director of Arroyo's Military Logistics Program, moderates a discussion of military logistics among Arroyo researchers and members of the U.S. Army CASCOM.

John Folkeson presents details of Arroyo's new repair project in military logistics.



John Gordon (Influence of future international environment on U.S. military capabilities)

M.A., International Relations; M.B.A., St. Mary's University, Marymount University
Active duty military experience: Field artillery officer; Chief of the Doctrine Branch at Department of the Army

John Halliday (Organizational change and logistics, with focus on policy alternatives that improve logistics processes)

Ph.D., Public Policy Analysis, RAND Graduate School

Active duty military experience: Air Force assignments ranging from operational logistics at a tactical fighter wing to analytic positions at Air Force Logistics Command

Bryan Hallmark (Education, training and performance assessment of individuals and groups)

Ph.D., Social Psychology, The University of Connecticut

Elwyn Harris (C4I interoperability, space systems, missile defense and technology assessments)

Ph.D., Public Policy Analysis, RAND Graduate School

William Hix (Military manpower and personnel, military health care, support programs)

M.S., Operations Research/Systems Analysis, University of Rochester

Active duty military experience: Commanded armor platoon and company; commanded military intelligence brigade, served at Department of the Army and the Office of the Secretary of Defense

Kenneth Horn (Advanced technology assessments; system tradeoff analyses; public-private partnerships; space systems)

Ph.D., Aeronautics and Astronautics, Stanford University

Robert Howe (Organization and structure of future Army forces)

M.S., Operations Research/Statistics, Rensselaer Polytechnic Institute

Active duty military experience: Mixture of engineer and OR assignments

Leland Joe (C4I systems, concepts and operations; effect of information technologies on military organization and operations)

Ph.D., Operations Research, University of California, Los Angeles

David Kassing (Military logistics, deployment systems, planning and budgeting methodologies, and naval capabilities)

M.B.A., Business and Public Administration, Cornell University

Art Lackey (Military logistics, with an emphasis on supply, maintenance and finance)

B.S., Business Management, University of Maryland

Active duty military experience: Army logistics, from unit level to major command headquarters

Henry Leonard (National security and national military strategy, military doctrine, operations analysis, manpower, training)

M.P.A., Economics and Public Policy, Woodrow Wilson School of Public and International Affairs, Princeton University

Active duty military experience: Commanded engineer units through brigade level; service at Department of the Army

Dina Levy (Training design and evaluation; assessment of human performance; personnel policy implications of the Army Distance Learning Program)

Ph.D., Cognitive Psychology, University of California, Los Angeles

Leslie Lewis (Strategic planning, resource allocation and management, organizational and process redesign, and acquisition reform)

Ph.D., History and Economics, University of California, Los Angeles

Matthew Lewis (Applying information technologies to education and training, and applying business re-engineering principles to military logistics)

Ph.D., Cognitive Psychology, Carnegie Mellon University

Thomas Lippiatt (Reserve component force structure and training; Army logistics)
M.S., Computer Methods, University of California, Los Angeles

John Matsumura (Potential military utility of advanced technologies, often using high-resolution simulation and modeling)

M.S., Engineering Mechanics, The Pennsylvania State University

Kevin McCarthy (Army's engagement work—its structure, organization, and implications)

Ph.D., Sociology, University of Wisconsin

Tom McNaugher (Defense strategy and politics, including Persian Gulf military issues; East Asian security; defense politics in the United States)

Ph.D., Political Science, Harvard University
Active duty military experience: Advisor in Vietnam; mobilized as reserve officer for the Gulf War

Louis Moore (Modeling and simulation, information operations and space issues, theater- and campaign-level simulation development and use)

Ph.D., Mathematical Statistics, University of North Carolina at Chapel Hill

Military experience: U.S. Naval Reserve, Military Instructor of Mathematics, Naval Postgraduate School

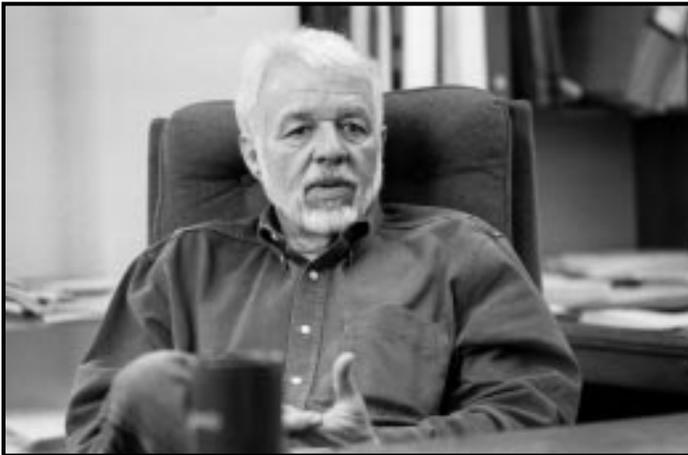
Brian Nichiporuk (Alternative geopolitical futures and the AAN initiative, the effect of global demographic trends on U.S. security interests, information warfare)

Ph.D., Political Science, Massachusetts Institute of Technology

David Oaks (Military logistics and reserve component mobilization)

Ph.D., Public Policy, RAND Graduate School

Military experience: Infantry officer; continues to serve in the U.S. Army Reserve, currently in the operations staff of a logistics headquarters unit



Clockwise from top left:

Thomas Lippiatt has researched Reserve Component training and deployment issues for nearly a decade.

Arroyo researchers Randall Steeb (left) and John Matsumura have done ground-breaking research on light forces and military technology.

LTC Joseph Walden leads a discussion on the continuous improvement of Army logistics at RAND's Velocity Management Boot Camp.

Arroyo's Director David Chu (left) with Walt Hollis, Deputy Under Secretary of the Army for Operations Research, at the Senior Analysts' Review.

RAND vice president Michael Rich discusses Army personnel policy with LTG David Ohle, Deputy Chief of Staff for Personnel.



Bruce Orvis (Personnel management; recruiting policy and resources; soldier characteristics, training and performance; productivity improvement; integration of manpower, personnel, and training issues in the military acquisition process)
Ph.D., Psychology, University of California, Los Angeles

Walter Perry (Application of game simulations to military command and control problems and crisis management; methods for representing information operations in simulations and analyzing large command and control problems through network modeling)
Ph.D., Information Technology, George Mason University

Active duty military experience: Service as signal corps officer including service in the Republic of Vietnam (1967–1968)

Ellen Pint (Effects of financial management policies on the Army logistics system)
Ph.D., Business (Economic Analysis and Policy), Graduate School of Business, Stanford University

J. Michael Polich (U.S. Army Reserve readiness; military training and performance; military recruiting and personnel policy; control of substance abuse; survey design and analysis)
Ph.D., Sociology, Harvard University

Dan Relles (Statistical computing, data analysis, sampling, linear models, data management, military logistics)
Ph.D., Statistics, Yale University

Marc Robbins (Military logistics)
Ph.D., Politics and Near Eastern Studies, Princeton University

Narayan Sastry (Demographics of recruiting and trends in the youth population)
Ph.D., Demography and Public Affairs, Princeton University

John Schrader (Strategic resource planning at the headquarters level [OSD, Joint Staff] with emphasis on integrating operational demands with competing capabilities)
Ph.D., Operations Research, Naval Postgraduate School

Active duty military experience: Command of destroyers; arms control policy advisor to CNO

Michael Shanley (Resource and cost management, including activity-based management; military personnel and training; innovation and organizational change; civilian education distance learning; spreadsheet modeling)
Ph.D., Policy Analysis, RAND Graduate School

Herb Shukiar (Military manpower and personnel planning; mathematical modeling and other operations research methodologies; high-level computer system design and evaluation)
B.A., Mathematics, University of California, Los Angeles

Jerry Sollinger (Logic and structure of written documents and oral presentations)
Ph.D., English, University of Pittsburgh
Active duty military experience: Command of artillery units through brigade level, service at Department of the Army

Ron Sortor (Role of reserves in U.S. military and the manpower, personnel, and training implications of alternative reserve force policies and structures; implications of operations other than war for Army force structure and personnel policies)
M.S., Industrial Engineering, University of Pittsburgh

Active duty military experience: Operations research analyst at Department of the Air Force and Office of the Secretary of Defense

Randall Steeb (Robotics, distributed simulation, light forces improvements, advanced fire support systems, air traffic control systems, decision support systems, unmanned aerial vehicles, military operations in urban terrain, combat vehicle design, and microelectromechanical systems)
Ph.D., Systems Engineering, University of California, Los Angeles

Paul Steinberg (Communications analysis with a current focus on force development and technology)
Ph.D., English, University of California, Berkeley

Thomas Szayna (Post–Cold War sources of conflict, intrastate conflict, peace operations, European security)
M.I.S., International Relations, Claremont Graduate School

Jennifer Taw (U.S. Army involvement in and requirements for military operations other than war, ranging from counterterrorism and counterinsurgency to peace operations and management)
Ph.D., Political Science, University of California, Los Angeles

Ashley Tellis (International relations theory; military strategy and proliferation issues; U.S.-Asian security relations)
Ph.D., Political Science, University of Chicago

Mark Wang (Military logistics, communications and information technologies in support of business processes)
Sc.D., Physics, Massachusetts Institute of Technology

James Wendt (National military strategy, arms control, basing, and East Asian security)
Ph.D., Sociology, University of California, Berkeley

John Winkler (Military manpower and training)
Ph.D., Social Psychology, Harvard University

Carolyn Wong (Strategies to manage the R&D of advanced technologies, with emphasis on the role of alternatives in the development of military science and technology)
Ph.D., Electrical Engineering (Operations Research), University of California, Los Angeles



Clockwise from top left:

Arroyo researcher Bruce Orvis (left) and Program Director Michael Polich discuss Army personnel resource management with Herb Fallin (SARDA) at the Senior Analysts' Review.

The Honorable Bernard Rostker, Under Secretary of the Army, attends the Senior Analysts' Review at RAND. Also pictured are Tom McNaugher (left), Deputy Director of the Arroyo Center, Lynn Davis (center), former Under Secretary of State, and Arroyo researcher Richard Darilek (right).

Bruce Orvis and Michael Shanley review research on military personnel and training.

Jennifer Taw is engaged in projects related to U.S. Army involvement in and requirements for military operations other than war.

Mark Wang (left), Pat Boren, and Ken Girardini review data for Army logistics studies.

