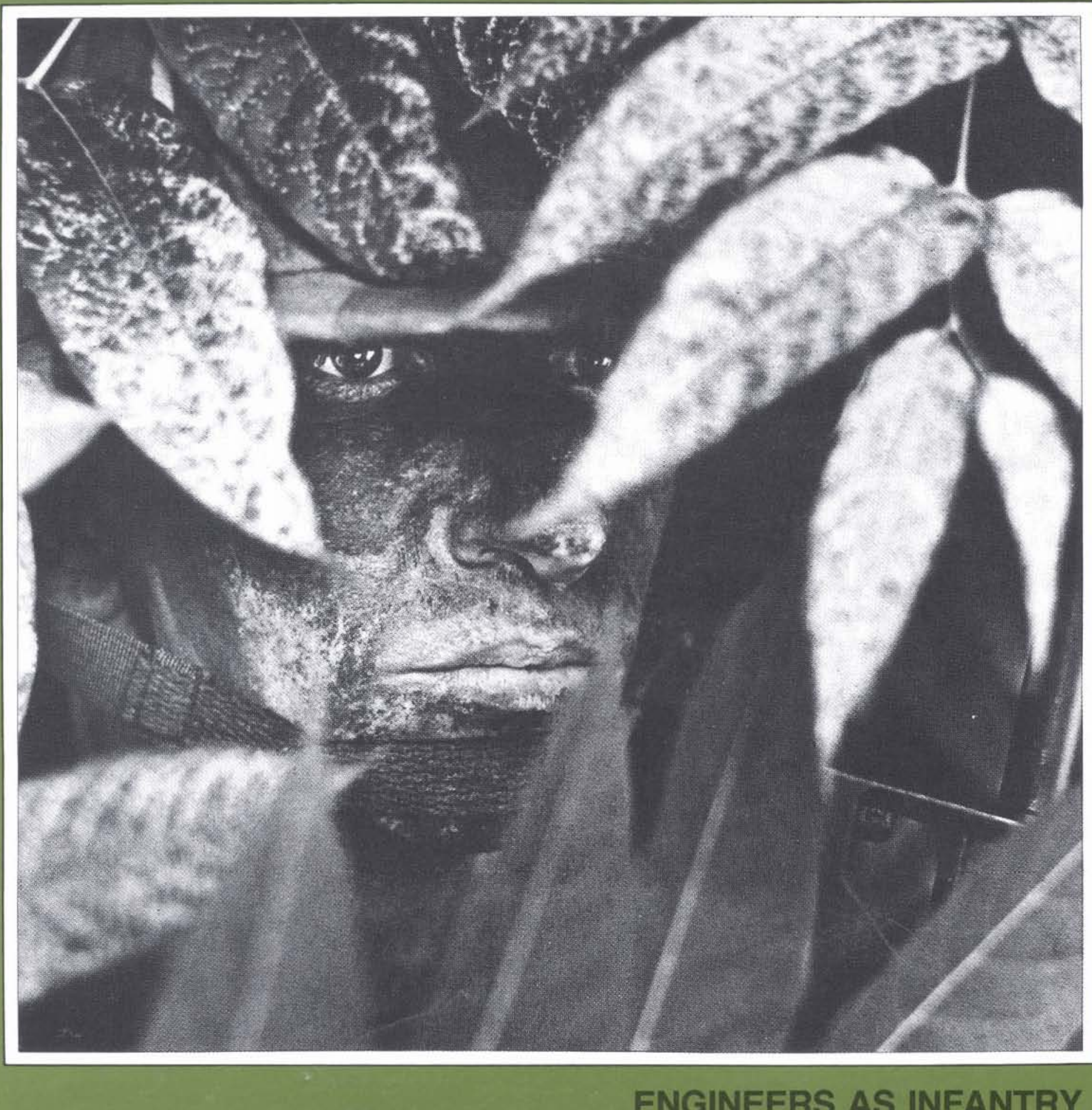
Engineer

THE MAGAZINE FOR ARMY ENGINEERS

FALL 1982



ENGINEERS AS INFANTRY

ALSO: THE COMBAT ENGINEER CALCULATOR . . . SUPPORTING RANGER OPERATIONS

On the cover:

The experiences of two engineer battalions training as infantry is our cover story. Though a secondary combat engineer mission, serving as infantry is, as the author notes, "... a wartime mission often assumed at a critical time and at a critical place." (Photo by John Florence)

Special thanks to **Jim Wilson** *and to the artists and proofreaders in the Engineer School's Training Literature Division.*

Engineer

VOLUME 12 FALL 1982 NUMBER 3

FEATURES

8 **A Materially Different Bridge**
by Richard W. Helmke

11 **Predicting Concrete Quality**
by Debbie J. Lawrence

12 **Washington's Legacies to the Modern Army**
by David Curtis Skaggs, Ph.D.

16 **U.S. vs. Soviet Engineer Training**
by CPT George D. Gagaris

20 **Engineers as Infantry**
by LTC James M. Cullem

25 **The German Territorial Army**
by LTC Hubertus Dunschen

29 **The Engineer Calculator**
by John M. Deponai

36 **Engineer Support to Ranger Operations**
by 1LT Robert B. Underwood III

40 **Paint Problems**
by Alfred Beitelman

Lessons learned *p. 20*

Tests at Belvoir *p. 29*

"Outstanding job" *p. 36*

DEPARTMENTS

2 CLEAR THE WAY

6 FORUM

3 NEWS & NOTES

28 ENGINEER PROBLEM

41 ENGINEER SOLUTION

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A new plan for ENGINEER

BY MG JAMES N. ELLIS
Commandant, U.S. Army Engineer School

MG Ellis

As you know, ENGINEER depends upon its readers to supply the majority of articles and information in each issue. This allows each of us the opportunity to positively influence the quality and content of our branch journal. It is important to take advantage of that opportunity.

New Program

For our part, we at the Engineer School are working to enhance the content of the magazine. In civilian terms, I would be considered the ENGINEER publisher so it is appropriate that I review for you the highlights of our new editorial plan.

First of all, ENGINEER remains a quarterly publication and will continue focusing upon combat engineering. Beginning with the next issue, however, each edition of ENGINEER will be "sponsored" by one of the School's four directorates (Combat Developments, Engineer Force Management, Training Developments and Training and Doctrine). The sponsoring directorate will have space for several feature articles that support a general directorate theme. We hope this will give you greater insight into the major issues and concerns at the School. This is important because, ultimately, many of these topics become translated into policies that directly affect your career or how you perform your job. In addition to sponsoring one issue per year, each directorate and the Defense Mapping School will have a news and information column in every ENGINEER.

News From MILPERCEN

There are other changes you'll see in the next issue. I'm very pleased that LTC(P) Paul Chinen at the Engineer Officer Personnel Management Directorate and LTC Liston Edge at the Enlisted Personnel Management Directorate (both at MILPERCEN) will supply personnel news for us in every issue. Many of you in the field have asked ENGINEER to expand its coverage of personnel news. This is one of the ways we are meeting that need.

CSM Column

The Engineer Center command sergeant major will also have a regular column beginning with the winter issue; a welcome complement to "Clear the Way," and one tailored specifically for the NCO. The USAEC CSM is my principle advisor on all engineer enlisted personnel matters but focuses primarily on the NCO corps.

Another change begins in this issue. Professor David Skaggs of Bowling Green State University has given us the first in our new military history series. His article, "Washington's Legacies to the Modern Army," is appropriate to initiate the series. As a young surveyor, Washington began his first surveying expedition from Belvoir on grounds now part of the Engineer School. In the traditional sense, we like to claim General Washington as one of the Corps. Future articles in the history series will concentrate specifically on engineer history. The study of military history should be high on your professional development agenda. The world's great military leaders have invariably been serious students of military history. I urge you to tap this same resource. We will help.

Bright Ideas

And finally, I'm requesting your support for a new department called "Bright Ideas." One of the biggest favors we can do for ourselves is to review and adopt, if appropriate, the innovations and creative problem-solving techniques others have used successfully. The first step, though, is to get those bright ideas out into the open where all engineers can examine them. I'm talking about pointers on a better way to organize training, combat engineer/construction tips, or improving unit administrative or supply procedures. What we want here are pithy items; a few lines to several paragraphs. Include an address and phone number so readers can obtain details directly from the individual or unit concerned. If your bright idea is article length, then it's in a different category and will be welcomed as a feature story. I hope you will agree this new department could become one of the most valuable sections of the magazine. I look forward to reading about your bright ideas in ENGINEER.

As ENGINEER Magazine evolves under this new editorial plan, we hope you will find the journal even more meaningful. We look forward to your continued support as we . . .

CLEAR THE WAY

JNE

News & Notes

1981 ITSCHNER & STURGIS WINNERS HONORED

Congratulations to the 1981 Itschner Award winners, recognized at the 115th Annual Engineer Dinner held at Fort Belvoir, Va., last May. Also honored at the dinner was the recipient of the 1981 Sturgis Medal.

The Sturgis Medal is presented each year to an active duty enlisted engineer in recognition of outstanding contributions to military troop construction or base maintenance. This year's winner was SSG Jackie L. Thomas, Headquarters, 79th Engineer Battalion (Combat) (Heavy), 18th Engineer Brigade, Germany.

The Itschner Awards recognize the most outstanding engineer company of the active Army, Army Reserve and Army National Guard, for engineering construction and community service. The 1981 winners were:

Active Army: C Company, 78th Engineer Battalion (Combat), 7th Engineer Brigade, VII Corps, Germany.

Army Reserve: D Company, 844th Engineer Battalion (Combat) (Heavy), Kingsport, Tenn.

Army National Guard: B Company, 262d Engineer Battalion (Combat) (Corps), Belfast, Maine.

ENGINEERS BUILD WORLD'S FAIR BRIDGE

Photo by David Luttrell

A community service project by the Army Reserve's 844th Engineer Battalion (Combat) (Heavy) made life a little more pleasant for thousands of visitors to the 1982 World's Fair in Knoxville, Tenn.

The 844th constructed a 290 foot triple-single Bailey bridge for pedestrian traffic so visitors could reach the Tennessee Valley Authority's energy exhibit without having to cross a heavily traveled roadway.

The bridge was constructed in three sections, and a crane was used to place them because of insufficient room for normal construction and launching.

The 844th's D Company was among this year's Itschner Award winners (see above).

News & Notes

READY RESERVISTS AID ARMY FROM HOME

The Engineer School found a unique way to combat manpower and fund shortages when preparing training packets for instructors and students at USAR schools. Qualified members of the Individual Ready Reserve were contacted and asked if they would prepare, at home, instructional units related to their specialty in return for retirement points.

Because Individual Ready Reservists are not assigned to troop units, they form a ready manpower pool. The Office of the Chief, Army Reserve, reports that of 100 Reservists contacted, about 30 expressed an interest. The Reservists were sent an administrative packet specifying the end product desired, specific learning objectives for each course and supporting reference materials. The Reservists also had access to the Engineer Hotline for guidance, problem-solving or administrative support.

Army Regulation 140–185 outlines the procedures for such ventures. Basically, the Individual Ready Reservist earns one retirement point for each four hours of work performed.

According to a spokesman at the Engineer School, the project was a great success and high quality results were obtained. Agencies or individuals interested in starting similar programs may contact MAJ Jerry L. Crowder at the School. Call AV 354-6190 or 800–336-3095.

SCHOOL'S TUDOR AWARD TO CPT MICHAEL PELKEY

Congratulations to CPT Michael P. Pelkey, recipient of the Engineer School's Tudor Award for academic achievement in military engineering.

The award, in honor of Ralph A. Tudor, a 1923 graduate of the U.S. Military Academy, is presented annually to the Engineer Officer Advanced Course (EOAC) student with the most outstanding achievements in academics, physical fitness, class effectiveness and contributions to the school.

Among Pelkey's accomplishments while attending EOAC class 1–81 were a grade point average of 97 and a score of 298 out of a possible 300 on the Army Physical Readiness Test. Additionally, Pelkey competed in the Washington, D.C., Marine Corps Marathon; passed the Virgina Professional Engineer examination; was a member of the class football team and served as a full-time trainer for 40 Engineer Officer Basic Course students.

Pelkey is assigned to HHC, 18th Engineer Brigade, Karlsruhe, Germany.

ENGINEERS PREPARE GALLANT EAGLE SITE

Soldiers of D Company, 864th Engineer Battalion, Presidio of San Francisco, Cal., literally paved the way for units participating in Gallant Eagle 82. The soldiers deployed early to grade 50 miles of roadway, repair aircraft landing strips, clear a helipad site and construct 12 miles of antitank ditches.

An estimated 1,300 fixed-wing aircraft, 450 helicopters, 1,100 wheeled vehicles and 800 tracked vehicles were used in the training, with D Company providing a 320,000-gallon fuel-storage depot site and a 140-tent cantonment complete with shower points.

Gallant Eagle 82, a United States Readiness Command sponsored exercise held at Fort Irwin, Cal., last spring, involved nearly 40,000 soldiers and civilians in the largest Rapid Deployment Force field exercise yet.

LEGISLATION SEEKS PROMOTION OF RESERVISTS ON ACTIVE DUTY

The Department of the Army has proposed legislation allowing promotion of certain Reserve officers serving in Active Guard/Reserve (AGR) assignments.

Under existing interpretations of the law, Army Reserve officers on active duty who are promoted to a Reserve grade higher than that held when ordered to active duty, may not serve in the higher grade while on active duty. The Reservist must either leave active duty or accept appointment in the Army of the United States in a temporary grade equal to the grade in which he served before the promotion.

The legislative proposal would effect non-obligated Reserve officers serving on active duty whose promotions have been postponed. These delays have made it increasingly difficult to attract and retain quality officers for the expanding AGR program, the Office of the Chief, Army Reserve reports.

If Congress approves the proposal, these officers would still be subject to the grade limitations of Section 524 of the Defense Officer Personnel Management Act (DOPMA).

Under the proposal, a Reserve officer on active duty selected for promotion would be eligible to be reordered to active duty in the higher grade, provided there was a vacancy in that grade available under DOPMA grade table limits for AGR officers. If no vacancy exists, the officer would continue to serve in the lower grade until a vacancy occurred, or until he completed his tour and was released from active duty. At that time, he would be promoted to the higher grade, with his date of rank retroactive to the date on which he was eligible to be promoted.

Chaplain (CPT) Nicholas J. Kusevich, 17th Engineer Battalion, 2d Armored Division, conducts a field mass wearing olive drab vestments made from an Army parachute. Kusevich is one of only 10 Eastern Orthodox priests in the Army. Developed in Eastern Europe, the religion includes Greeks, Ukrainians, Romanians and Russians. There are more than six million of the Eastern Orthodox faith in the United States. (Photo by Mark Vitullo)

DIVERS NEEDED FOR RIBBON BRIDGE COMPANIES

Seven-man diving sections will be added to nondivisional ribbon bridge companies (TOE 5–79H) in early fiscal year 1983.

Divers, MOS OOB, will support bridging and ferry operations by performing approach and river bottom reconnaissance, building bridge protection systems, repairing bridges and recovering sunken equipment. Some sections will conduct SCUBA (self-contained underwater breathing apparatus) operations.

Soldiers E2 through E4 can volunteer for deep sea diving training if they are less than 30 years old, pass the Navy swim test and will have 21 months service remaining after the 12-week diving course.

Contact the CMF 51 assignment officer at MILPERCEN (AV 221–7710) for additional information.

—FORUM—

THE SOVIET SOLDIER

Is Ivan really 10 feet tall?

by Les Aspin

The Pentagon normally reduces comparisons of Soviet and American military power to "bean counts," to use its own term. In the standard news magazine chart, this boils down to a row of Soviet tanks and a shorter row of American tanks. This chart usually includes a row of Soviet soldiers in silhouette and a shorter row of American soldiers in silhouette.

The bean count approach overlooks the more crucial question of quality. This is especially true of manpower. The United States Army tends to be dismissed by liberals and conservatives alike as a collection of misfits and dummies. The Soviet Army on the other hand, consistently comes off as a corps of tough, if not brutal, professionals—almost superhuman.

Military attachés with the United States liaison mission in West Germany have visited Soviet forces in East Germany and come away to write with amazement at the tremendous physical specimens filling that force. Their evidence: not one single soldier was seen wearing eyeglasses. These observations have been quoted approvingly dozens of times without anyone's mentioning that the Soviet Army does not issue eyeglasses and that, therefore, many of those soldiers can't see well enough to aim their rifles.

Those who tout the wonders of the Soviet military tend to be nearsighted, too.

Life in the Red Army is tough—not Marine Corps tough, but concentration camp tough. The evidence is available from a variety of sources. Some of the most interesting comes from American and European interviews with Soviet émigrés. The themes that run through their descriptions of Soviet military life paint a far different picture from that usually held by Americans:

- Alcoholism is rampant, dwarfing the drug problem faced by the United States armed forces.
- Food is poor. Young recruits are often denied all but table scraps.
- Physical brutality is the norm, with senior soldiers freely allowed to get their "kicks" by assaulting younger soldiers.

The composite picture is perhaps most dramatically summed up by the results of a survey by Richard A. Gabriel, author of *The New Red Legions,* in which 113 Soviet émigrés were asked: "Did anyone in your unit ever attempt to commit suicide?" More than 53 percent answered yes. That points to something considerably different from tough training.

The Soviet military is far from the classless society that ideology decrees. The men in each unit are in effect divided into two distinct classes. The upper class—those who have been in uniform more than a year—are allowed to unleash a reign of terror on the lower class.

Kirill Podrabinek, a conscript who served in an infantry unit in Turkmenistan in the mid-1970s, graphically described conditions in a letter smuggled out of the Soviet Union in 1976 to émigrés in West Germany. He said that younger troops were beaten from the first day they arrived in the unit. The senior troops "instill terror right away," he wrote.

It's not just physical assault that causes demoralization. As many émigrés have said, the food in the barracks is poor—when there is food. Lieutenant Viktor Belenko, who flew his MIG to Japan in 1976, said, "I think if we took a pig from a good *kholkhoz* (state farm) and put it in a mess hall, that pig would faint."

A little overdrawn, perhaps. But Podrabinek describes how younger troops are deprived of food. First-year soldiers sit at the end of the table away from the pot of food. Senior soldiers are served first. "It is understood that if there is something worth looking at in the pot, let's say potatoes, and not just barley gruel, the person at the foot of the table may not get any. At the foot sits the weakest youngster or the one who has received the worst maltreatment."

Another former soldier, Aleksandr Makushechev, a sergeant, has described how brutality and deprivation of food cause friction between the two classes of soldiers. Interviewed on Radio Liberty, he said that first-year soldiers were often denied cartridges on the rifle range for fear they might shoot their seniors.

In the United States, the military worries about alcohol abuse. In the Red Army, they no longer bother to worry. Alcoholism defines Soviet society as apple pie defines American society, so the fact that drinking is endemic in the military is not surprising. Soviet soldiers, paid the equivalent of about $1.50 a week, go to considerable trouble to find free alcohol. Lieutenant Belenko described how his mates would steal, sell or drink the alcohol intended for the coolant systems of MIG fighters. Others tell of sneaking into army tanks to extract brake fluid in order to drink it.

Soviet leaders frown on drug abuse. Despite this, Soviet émigrés report growing use of *plan* (made from opium), *anasha* (a form of hashish) and *chefir* (a stimulant made by boiling tea leaves), not to mention medicines stolen from medical units.

When we look at the Soviet Army and see a 10-foot-tall hardened soldier, we may be looking at a "Potemkin village." In fact, the Soviet Army once literally created a Potemkin military unit to ensure a perfect performance for the hierarchy, the pseudonymous Viktor Suvorov, a former tank company commander, relates in his book, *The Liberators*. In 1967, officers were assembled and dressed as privates to make sure that everyone involved in the exercise performed well. In a real war, however, that option for mobilizing quality troops does not present itself.

The two keys to the effectiveness of a fighting unit are cohesion and leadership.

Cohesion stems from pride and mutual respect among the troops, who fight because to do otherwise would be to forfeit the esteem of their comrades. But comradeship is an element no longer found in quantity in the Soviet forces. The system of two classes among the troops doesn't generate cohesion; it militates against it. In Professor Gabriel's survey of former soldiers, a remarkable 30 percent said they had not made even one close friend in the service. You cannot have cohesion without the bonds of friendship. Some think that tough living conditions produce a tough soldier. Podrabinek says that's nonsense: "It makes them cowards. A slave who has accepted his lot is always cowardly."

Unmasking the Soviet soldier: How good is he?

Leadership is the second key element in forming a real fighting force. The quality of that leadership is indicated by the failure of Soviet officers to address the brutality, the drug and alcohol abuse, the food deprivation and the many other unsavory characteristics of Soviet military life.

This failure is built into the system. Soviet military regulations require commanders to report offenses by subordinates to the next higher headquarters. But the regulations also hold the commander responsible for the subordinate's conduct. The result is that at every level breaches are ignored. Even the Soviet press has acknowledged that reports to headquarters are often little more than "eyewash" as officers seek to cover up indiscipline.

There is a danger of overstating this case. Not every Soviet soldier is beneath contempt. We should not replace the myth of the 10-foot-tall hardened Russian infantryman with yet another myth of a three-foot-tall starving coward holding an empty cartridge case.

What is needed is a better perspective when Soviet and American armed forces are compared to each other.

Is the American military filled with too many "dummies"? The United States armed forces will not accept the least intelligent one-seventh of the population. Soviet law provides no such exemption. Perhaps the Soviet Army takes in young men from the country's minorities who have only the barest acquaintance with the Russian language. Furthermore, as the birth rate falls among Russians and rises among, say, Uzbeks, Kazakhs and other minorities, the proportion of these peoples who do not speak Russian will rise to one-third of all recruits, according to a United States Census Bureau analysis of Soviet census data.

Are we suffering an absence of experienced sergeants because "only" one-third of those finishing their tours of duty re-enlist? In the Soviet military, only one percent re-enlist, and the military doesn't really have any corps of experienced noncommissioned officers.

The Soviet Army does present a serious threat. But we only fool ourselves and threaten to undermine our own morale when we exaggerate the qualities of the Soviet military.

Les Aspin, (D–Wis.), is a member of the House Armed Services Committee. Reprinted from the **New York Times,** *June 8, 1982.*

A Materially Different Military Bridge

by Richard W. Helmke

The material isn't new, but its application to military bridge structures is. The material is generally referred to as "composite material," a high strength continuous fiber in conjunction with epoxy resin.

A prototype military bridge system produced by the Trilateral (U.S., U.K., F.R.G.) Design and Analysis Group, resulted in the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, Va., erecting a test bed for comparison of conventional and composite material bridge components.

The approach to testing was to replace individual metallic elements within the test bed bridge with composite material elements. While this technique penalized the design slightly at connection points, it provided side by side comparison under duplicate load conditions. A 31-meter dry gap support bridge (later expanded to 52 meters, Figure 1) served as the test bed bridge.

The conversion to composite materials design for bridge structures is considerably more involved than just the substitution of one material for another on a property by property basis. Probably the most outstanding difference in the design approach to composite materials, is that the module of elasticity (E) of the material is now a variable, and as such, subject to specification much as we now specify the physical properties of common construction materials (hardness, yield strength, etc.) The effect of this variable for a given material composition allows us to stiffen and relax structural elongations without adding or reducing the amount of material used.

In the test bed bridge, the application of composite materials was demonstrated in the bottom chord sandwich panel, the traversing beam, the bridge tensile reinforcement system and the wound web module.

The Bottom Chord

The area most sensitive to improvements in strength and stiffness, is the bottom surface of the test bed bridge. The old bottom surface was a 24 inch wide, five-eighths of an inch thick, aluminum plate. The new composite bottom is also 24 inches wide and five-eighths inches thick, but is a layered plate of aluminum, graphite-epoxy and aluminum.

The sandwich panel is made up of a one-eighth inch thick aluminum sheet, a three-eighths of an inch thick sheet of graphite-epoxy, and another one-eighth inch thick aluminum sheet, fully bonded as shown in Figure 2. This encapsulates and protects the brittle graphite with ductile aluminum, and the sandwich configuration retains 80 percent of the traverse stiffness of the all aluminum plate it replaces. Transverse stiffness is required for bank support in a military bridge since the location of the bridge reaction can fall anywhere on the bottom chord.

To take full advantage of the fluid plastic state through which the composite material passes during part fabrication, the manufacturing method was developed concurrently with the structural design. A piece of composite material 20 inches wide by .375 inches thick by seven meters long, was needed for the bottom chord panel.

It was noted that linear composites had a poor bearing strength, that attachment of the pin connector to the bottom chord would require undesirable bolt holes through the composite material and that the method of fabrication should be as inexpensive as possible.

To satisfy all these requirements, a continuous wet winding of graphite fiber directly onto the aluminum sheet, two panels at a time, was used. The process works as follows:

- *The mandrel is placed on the vertical winding machine and epoxy blanks are attached to the areas where bolt holes are to be drilled.*
- *Multiple rows of graphite are threaded through an epoxy impregnating roller and level-wound over the mandrel and* around *the epoxy blanks.*
- *The finished winding is oven cured.*
- *The cured panel is bonded to the aluminum face sheet and bolt holes are drilled through the epoxy blanks, leaving the graphite fiber unbroken. (The composite volume fraction is slightly higher in the bolt hole where the epoxy has been pressed out.)*

This winding technique results in a rather plain looking, close tolerance panel that is produced inexpensively and with little labor. Once installed within the bridge it is inconspicuous. From the outside the composite chords look the same as the all-aluminum chords, but looks are the only thing in this bridge that remain the same.

The single change has converted a 60-ton capacity bridge to a 70-ton capacity bridge, with no increase in stress to the metallic components. The new bottom panels offer another bonus—they are 30 percent lighter than the solid aluminum plates. A stronger, lighter bridge, with no changes to the physical geometry. It's almost magic!

The Traversing Beam

The traversing beam is the structural element used to emplace and recover the bridge at the bridging site. The beam traverses back and forth within the bridge structure but never leaves its location between the treadways. Since it is totally supported within the cross braces of the bridge, it deflects the same elastic curve as the bridge does when the bridge is loaded. In other words, the beam sees both launching loads and bridge loads. The current all aluminum beam weighs 110 pounds per foot, and constitutes 25 percent of the entire bridge structure. The all composite beam weighs 35 pounds per foot and due to its increased stiffness carries more of the bridge load. The seven meter long test bed beams were pinned at each end to produce as much traversing beam as there was bridge. They were fabricated using many of the same techniques as used for the sandwich chord. A simplified fabrication sequence is:

- *Wind a seven meter tubular mandrel with graphite/epoxy at +45°/90°/−45° plys.*
- *Wind continuous graphite loops (longos) around steel spools on seven meter centers.*
- *Lay the longo on the box winding both top and bottom sandwiches together to form multi-fingered shear joints. Note that the longos are longitudinally staggered to produce the desired male/female pin joints.*
- *Spacers, sandwich core and previously wound slider tracks are laid on the mandrel at the desired location.*
- *The entire winding/layup is now over-wound with several plys of graphite/epoxy completing the cross-section.*
- *The entire bundle is then inserted into a mold and oven cured to produce a final configuration which requires neither joining nor machining.*

This application uses medium modules graphite material. Although it is more costly (three times) than the metallic element it replaces, the projected energy savings due to the reduction in mass (7,500 pounds) which must be transported, justifies the high production cost.

Bridge Reinforcement

A third area of our test bed common to other military bridges, was the long span reinforcement system. We used a cable/bar tensile system suspended beneath the main bridge structure. The variable concern in this system is the stretch or deflection of the cable system, which in turn controls the deflection and load seen by the main bridge structure. The stretch or deflection of the cable for any given length of cable is proportional to the cross-sectional area (A) and the modulus of elasticity (E). By using a composite material with a very high E, such as 55 mpsi graphite, it is easy to reduce the cable area (since the cable load is low) and, therefore, the weight of the cable.

The overall effect of the change in cable material is to transform a steel tensile element that weighs 200 pounds and requires four men to emplace, into a composite (kevlar or graphite) element that weighs 50 pounds and can be emplaced by one man in half the time.

The method of production for this element is, again, continuous wet winding of the composite into a continuous loop. This continuous loop, folded end to end, is given a 90 degree twist and then molded into a rigid link. Each 3.5 meter link is interthreaded to the next, with pin connections required only at the king post and bridge termination.

The Web Module

The web structure used in the test bed bridge was a dimple plate web configuration. The dimple plate is made by pressing rows and columns of dimples into sheets of aluminum, placing the dimples nose to nose and spot welding each

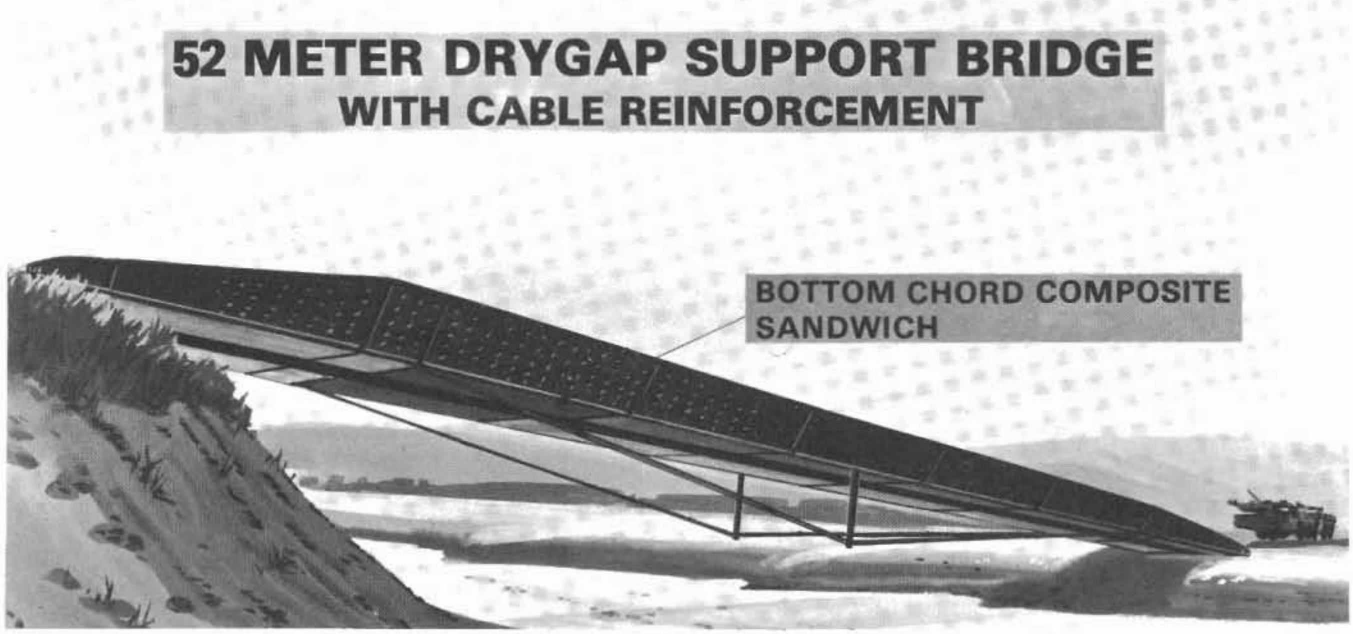

Figure 1. Test bed bridge showing location of bottom chord sandwich panel and bridge reinforcement system.

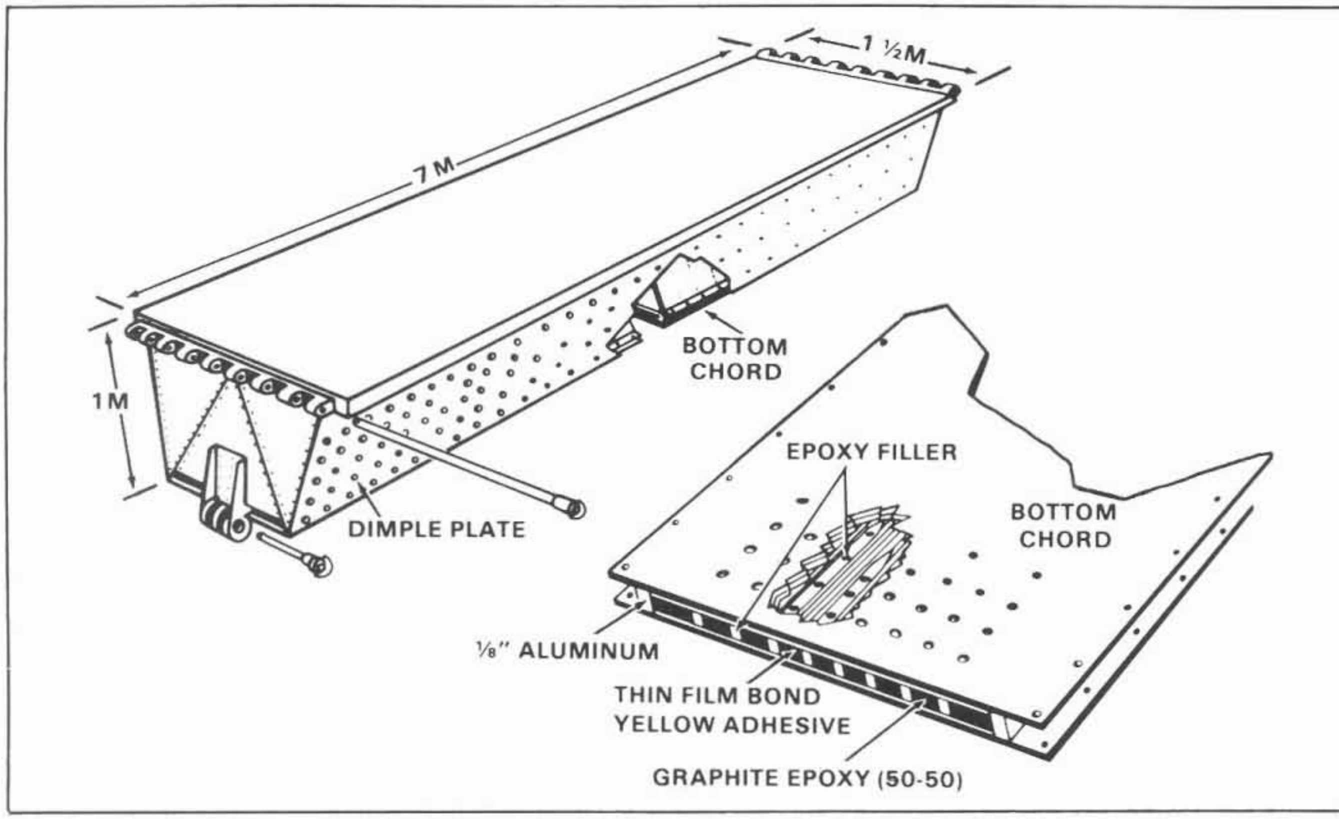

Figure 2. The bottom chord sandwich panel consists of a .125 inch 7075–T63 aluminum face sheet bonded to 50 million psi modulus graphite-epoxy composite.

dimple. In theory, this produces a stiff, stable, thin skinned web which is water tight and easily weld repaired. In reality, the thickness of the aluminum sheet (.08 inches) was controlled by the thinnest section that could be welded, and not by structural considerations which would have required less than half this thickness. The installation of the dimple plate webs requires 27 feet of weld per foot of treadway—and that does not count the 3,000 spot welds also required.

The component that replaced the dimple plate in the test bed bridge, was the web module. The special composite material feature to be exploited here, is the fluid plastic consistancy of the fabricated part prior to final configuration set. Simply stated, we can mold and shape it without machining. The method of fabrication for each web module is:

- *Inflate a flexible mandrel (long hollow tube).*
- *Wind the tube with composite.*
- *Lay on web spacers (built in stiffeners.)*
- *Wind it again with composite.*
- *Deflate the mandrel slightly and insert it into the mold shape desired. Reinflate.*

The result of this procedure is a bridge web configuration which duplicates the geometric constraints of the dimple system—a totally sealed, hollow-celled, stiff web structure which can be either bolted or bonded (probably both) to the top deck and to the bottom composite chord.

We are only beginning to test the applications of composite technology in military bridge structures. Although some of the designs proposed have been found to be less than optimal, the message seems clear. Composite materials are ready to enter the Army.

The material must be carefully placed to efficiently use its desirable characteristics. An increased number of material property variables are managed in design, and the fabrication techniques must be mastered in production, however, the opportunity for real innovation makes the additional mechanics worthwhile.

The common disclaimer, "that stuff is just too expensive," does not really apply to composite materials anymore. The basic raw material prices for graphite are expected to recede as demand and production increases, while inflation is driving up the cost of conventional materials. If we discard the "dollars per pound" block for a more realistic "dollars per product," we find that many applications are suprisingly cost effective right now. Composite materials have reached the bridge site and their impact will be felt in the 1980s.

Mr. Richard W. Helmke is chief, Concepts and Composites Branch, Marine and Bridge Laboratory, U.S. Mobility Equipment Research and Development Command, Fort Belvoir, Va. Since 1959, he has served in various civil service positions, including as the Army's chief designer for mobile bridge systems with assault, floating and tactical applications. Mr. Helmke chairs the Trilateral (U.S., U.K. and F.R.G.) Design and Analysis Group which gathered data for the recently published **Design and Test Code for Military Bridge Structures.** *He is a registered graduate professional engineer in Virginia.*

Predicting Concrete Quality

CERL's new Concrete Control Monitor determines quality 15 minutes after concrete is placed.

by Debbie J. Lawrence

The Corps of Engineers' new Concrete Quality Monitor (CQM) two-test system evaluates water and cement percentages in fresh concrete samples to predict the 28-day compressive and flexural strength potential of the mix. Currently, strengths of concrete cannot be predicted until seven days after placement, with final strength predictions made 28 days after placement. The CQM test of fresh concrete can be completed in 15 minutes.

The water test consists of mixing a known weight of concrete with a known volume and concentration of salt solution, then determining the salt concentration of the intermixed salt solution using a chloride meter. The free water in the concrete dilutes the salt solution, thus changing the salt concentration. The strength of the intermixed salt solution is directly related to the water in the concrete sample.

The concrete test separates the aggregate from the cement portion of a concrete sample, then uniformly suspends the cement in a fixed volume of water. A fixed volume sample of the suspended cement is dissolved in diluted nitric acid, and the calcium strength of the dissolved solution is determined using a calcium analyzer.

Because cement is mainly composed of calcium compounds, the calcium content of the dissolved solution is linearly proportional to the cement content of the mix.

Author uses the monitor.

Recent laboratory and field test results show the system can determine the water and cement content of concrete to ±5- to 7-percent, and estimate both compressive and flexural strength potentials to within 10- to 15-percent. The approximate equipment cost is $6,800.

The Corps' CQM has several significant advantages over other test methods. This system, and its predecessors the Kelly/Vail and CERL/KV systems, are the only systems that rapidly (within 10 to 15 minutes) determine both water and cement content in fresh concrete. However, the CQM system is easier to use than the Kelly/Vail and CERL/KV systems (which require precision preparation of a significant quantity and number of reagents). CQM testing relies on instrumental analysis and associated small quantites of prepackaged reagents.

The CQM system is also easy to transport and calibrate. The equipment may be disassembled and packed in crates small enough to be sent as excess baggage on commercial airlines. The system is calibrated by conducting a standard CQM cement content test which takes less than 10 minutes.

In addition to these advantages, the CQM system is versatile and cost effective. It can be used to determine the lime and cement content of stabilized soils, mixer efficiencies and the presence and concentration of chlorides in concrete. The cost of operating the system (on a per-test basis) is significantly less than conventional concrete cylinder testing.

The CQM is being used by the Corps of Engineers' Tulsa District on soil cement stabilization, by the Walla Walla District on roller compacted concrete at the Willow Creek Dam project, and the American Society of Testing and Materials is developing a tentative standard test procedure based on the CQM and CERL/KV systems.

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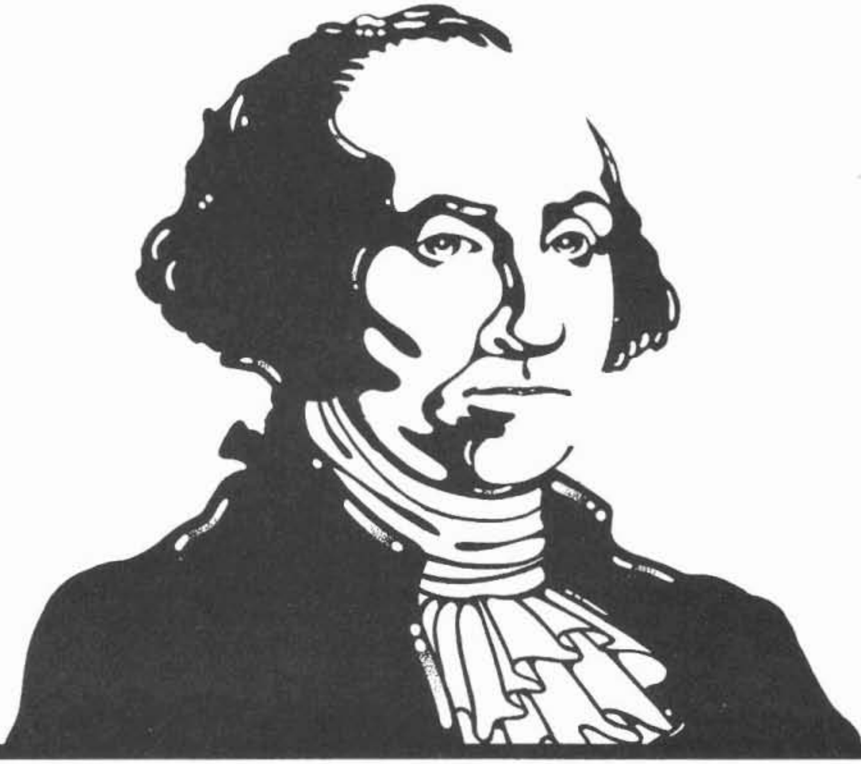

Washington's Legacies
To The Modern Army©

by David Curtis Skaggs, Ph.D.

A nineteenth-century biographer once described George Washington as "bolder than Alexander, more crafty than Hannibal, wiser than Caesar, more prudent than Gustavas Adolphus, more resourceful than Frederick, more sagacious than Napoleon and more successful than Scipio."

Surely no commander has exhibited all these virtures. However, neither do I subscribe to Gore Vidal's theory, stated in his novel, *Burr,* that "had (either Horatio) Gates or (Charles) Lee been placed in command of the Army, the war would have ended three years sooner."

Thus we are faced with a dual image of the commander of the Continental Army, and from this there is much to learn. For this purpose, I shall group his legacies into two categories—tactical and personal.

The best known of his tactical legacies is his use of surprise. "Surprise," wrote Douglas MacArthur, "is the most vital element for success in war." Few have exploited this "vital element" more successfully than George Washington. The victories at Trenton, Princeton, Stony Point and Yorktown provide examples all commanders should remember.

Surprise cannot be achieved without developing to a fine art the skills of military intelligence and deception. Washington's talents in these associated areas were excellent. His intelligence agents were legion but none exceeded the fact that the leading Loyalist journalist in British-held New York City was in his spy network. No enemy disposition or movement occurred without the American commander knowing of it. Deception of his own movements was critical in holding the main British army in Trenton while he undertook a forced march to Princeton. Both there and at Yorktown, His Majesty's generals were defeated due to surprise combined with vital intelligence and crafty deception.

Concurrent with surprise was the tactic of peripheral attack. After bitter defeats finally taught him otherwise, General Washington sought to attrit a superior enemy force through attacks at outposts. Trenton, Germantown, Paulus Hook, Stony Point and Yorktown epitomize this type operation. It is here that the modern Army has the most to learn from him. Since the age of Grant, American generals have sought the main enemy armed force and grappled with it until our superior firepower and manpower destroyed the opponent's will to resist.

Certainly we cannot expect such conditions to exist in possible war in Central Europe. George Washington learned what FM 100-5 seeks to teach us all: the U.S. Army must prepare its units to fight outnumbered and win. Washington's example of skillful concentration of force at decisive points is essential for all modern commanders to learn. Washington, wrote Douglas Southall Freeman, "was a bargain hunter. He always sought the largest gain for the least gore." Peripheral operations achieved this and allowed the Americans to control most of the North American land area despite many losses from Quebec to Charleston.

A third tactical legacy is Washington's use of defense. Modern strategy places extraordinary emphasis on offensive operations, almost to the exclusion of the critical role defense plays in forcing the enemy into situations that make him vulnerable. For Engineer officers, General Washington's skillful use of defensive fortifications cannot be overemphasized. Nowhere is this more apparent to contemporary Americans than by walking up to Fort Putnam above West Point and surveying the combination of defense in depth and mutual support that Thaddeus Kosciuszko designed to create the Hudson citadel from which Washington operated from 1778-83.

We need to learn more about the importance of tactical strong points and their significance to modern battle. We need not adopt a Maginot Line mentality to comprehend that the defense of Europe requires use of every civilian bulldozer, backhoe and cement mixer to provide the hostile strongholds that threaten the flanks and rear of any Warsaw Pact force. Moreover, from such positions can be made the type of peripheral attacks that Washington utilized at Stormy Point and Paulus Hook.

His final tactical legacy involves the use of combined operations. While our first commanding general was most inept at combined arms tactics (his failure to use cavalry and dragoons is a mystery to most commentators), his repeated plans to exploit the French Navy in the American theater is a study in frustration until it finally worked at Yorktown. From Newport, Rhode Island, to Savannah, Georgia, Washington's attempts from 1778 to 1780 to isolate a British garrison with a combination of land and naval forces failed. A less resolute commander would have given up, but not George Washington. With a persistence that modern commanders must emulate, he tried a fourth time. This time it worked. Such grand tactics are absolutely necessary on the modern battlefield and must be emulated despite our frustrations. Otherwise we cannot expect victory. The successful modern commander must be as much a diplomat as he is a general.

Examine Washington's most illustrious campaign—the Chesapeake encirclement of 1781. Here we see defense, surprise, peripherial attack and combined operations in exquisite execution.

The winter of 1780-81 represents the nadir of the American war effort. Inflation eroded the economy to where several hundred Continental dollars equaled one English pound. Mutiny in the ranks of the Continental Army threatened to destroy the only national institution existing in the country. Militarily the previous year saw the defeat of two "armies" sent to stop General Sir Henry Clinton's effort to destroy the rebellion by attacking its soft underbelly in the South. Defeats at Charleston and Camden left Georgia and most of South Carolina in British hands. Lord Cornwallis stood poised to invade North Carolina and Clinton sent a raiding party into Virginia. To stop this threatened loss of the whole South, Washington could only send a few Continentals under Nathanael Greene to the Carolinas and even fewer under Frederick von Steuben to Virginia. By mid-February the situation was desperate. One of Greene's reconnaissance forces under Daniel Morgan inflicted heavy losses to one of Cornwallis' flanking commands, but the act seemed only to enrage the British commander who promptly chased Greene across North Carolina. Meanwhile, newly commissioned British Brigadier Benedict Arnold led 1,500 redcoats up the James River to Richmond. Steuben seemed helpless to stop him and was replaced by Lafayette.

In May, Washington confided in his diary, "In a word—instead of having everything in readiness to take the field, we have nothing—and instead of having the prospect of a glorious offensive campaign before us, we have a bewildered, and gloomy defensive one—unless we should receive a powerful aid of ships—land troops and money from our generous allies and these, at present, are too contingent to build upon."

It was these contingencies that the success of the rebellion depended, and Washington sought to secure from his "generous allies" the troops, ships, and money necessary to wage a "glorious offensive campaign" against the center of British power in North America—New York City. Washington hoped that the new French naval commander Comte Francois de Grasse, then in the West Indies, and General Comte Jean Baptiste de Rochambeau's army at Newport would combine with the Continental Army to take New York. To this end, Generals Rochambeau and Washington met at Wethersfield, Conn., the last week of May 1781.

Rochambeau ostensibly agreed to the attack on Clinton's force beginning at Staten Island. Since such a move would place the French army on the west bank of the Hudson, Rochambeau was willing to accept this plan because from eastern New

Jersey he could more easily march toward the Chesapeake where he hoped to entrap Cornwallis' smaller force. Informing Admiral de Grasse of the Wethersfield decisions, he indicated his preference for the southern operation. Deploring the sorry state of the Continental Army, the French general urged de Grasse to bring enough ships, troops, and money to insure success against Cornwallis.

To few foreigners does the United States owe a more lasting debt than Admiral de Grasse. He did more than a weak ally could expect. He ignored explicit instructions from Paris to escort a West Indian merchant convoy to France. He secured 3,000 French troops from the Santo Domingo garrison, and not only received Governor Bernado de Galvez's permission to postpone a Franco-Spanish expedition against Jamacia, but also borrowed gold from His Catholic Majesty's coffers in Havana. When word of his pending expedition for the Chesapeake reached Washington, the American commander dropped his preference for New York and joined in the greatest combined operation in military history before the landing on Normandy.

If Washington's predilection for attacking New York deviated from his pattern of peripheral attack, his willingness to modify his plans indicates a flexibility characteristic of all great commanders. Moreover, he skillfully used his original plan as a deceptive cover for the Chesapeake operation, for surprise was a key to success. Clinton must feel threatened and Cornwallis must feel secure in order that the two not cooperate and ruin the opportunity.

Nowhere else do the tactical traits of Washington's generalship find better expression than in the Chesapeake encirclement. Secure in Fortress West Point, he had a defensive position unassailable by an 18th century army. Skillful in compromising his own inclinations for the locus of attack, he conducted a combined operation involving the movement of thousands of troops, hundreds of miles toward a single objective despite numerous obstacles to success. Managing a deception of two British generals, he achieved surprise that forced a significant defeat over an army which a mere 20 years earlier stood unchallenged in North America. Finally, he recognized that while attacking Cornwallis might not achieve a decisive victory over the British main force, the loss of such an important segment of His Britannic Majesty's army could force a major reassessment of the desirability of continuing the war by the leaders at Whitehall. Nowhere else can a modern Army officer find better examples of the interaction of defense, peripheral attack, surprise and joint operations, than in this episode.

Washington had character. No other attribute is so indefinable, yet so essential to military success . . .

Like all successful captains, George Washington had character. No other behavioral attribute is so indefinable, but none so essential to military success, than to be seen by one's associates and subordinates as having a force of personality that distinguishes the great leader from others. Washington had this trait.

Part of it undoubtedly derived from his superb physical condition. He survived eight years as commanding general without a day of leave and only three brief periods of sickness. He regularly rode horseback, often covering 15 miles before breakfast. He set an example of endurance unequaled by the heartiest Continental. Moreover, his well-proportioned, over six-foot physique, gave the image of the ideal leader.

But character involves more than appearance and physical condition. It requires a moral courage that is understood by all one's subordinates. His leadership was by example. Washington disciplined with justice and consideration, he promoted on the basis of talent, he solicited and respected the opinions of others, he wrote clear, concise and complete orders, he exemplified a true patriotism and sense of duty, and demonstrated courage on the battlefield and in accepting responsibility for error.

He received his lessons in leadership not at a branch school, but at the helm of scattered plantations. He learned to write clear directives not from following a five-paragraph field order, but as a correspondent in a trans-Atlantic commercial world. His tactical and strategic policies came not from training at a command and staff or war college, but from experience and observation. Those of us who benefit from the extensive educational program of the modern Army still have much to learn from this self taught gentleman, in leadership, tactics and strategy. Education is merely a short-cut to experience and George Washington exemplifies how that experience, no matter how acquired, can produce exceptional character in the great captains of history.

To this day he is a hard man to know. He had few personal friends, especially in the Army. He expected and received all the deference due his rank. Washington was aloof without being arrogant. He avoided familiarity with his fellow officers, yet he really cared for the welfare of his men. The troops came to believe in him. They knew he would ask no senseless sacrifice of their lives, that he would not destroy their chances of survival on the altar of his ambition. Obviously he was ambitious, but he did his duty as best he could and never sought aggrandizement at the expense of others. In the company of his officers and men he maintained a sense of presence; not familiar, not fatherly, not sentimental, Washington remained calm and imposing. His reserve was known to all. The Duc de Deux-Ponts described him as being "of a natural coldness and of a serious and noble approach."

Morally he walked the straight line and he quickly found his integrity constituted an important asset to be cultivated without boasting of it. He had an internal self-discipline that caused him to avoid acts that would cause public censure. He feared public criticism and avoided personality clashes whenever possible. While he could sometimes be vindictive (witness the court-martial of Charles Lee), he accepted the failures of others so long as they contributed to the subordinate's development into a better leader.

While no two great captains exhibit character in the same manner, George Washington exemplified how conscious integrity, patriotism, and responsibility constitute the essential ingredients of leadership. No modern captain can duplicate his personality, nor would one want to, but all leaders need those essential ingredients of character to inspire those who follow them through the trials of camp and combat.

A second ingredient of his personality was persistence. Like all warriors, he desired a short war. It became quickly obvious this would not be the case and he undertook those activities necessary for prolonged warfare. He raised a regular Army and avoided decisive conflict that might eliminate the Continental Army and its existence as the symbol of American nationhood. He grew with experience and persisted to the end despite defeat, discouragement, and defection.

A modern commentator may feel the Army has gone too far from persistence. The siren song of "win the first battle" may symbolize a revolution in our strategic thought antagonistic to the Washington legacy. Sure we would like to win the opening round, but frankly we must win the last. There will be those who argue that the first battle may be the last, but seldom has there been a one battle war—ask Hannibal, ask Napoleon, ask Hitler or Yamamoto about first battle victories. Persistence pays off, as Scipio, Wellington, Eisenhower and MacArthur can well testify. We must prepare not merely to win the first battle, but also to continue the fight. Persistence is a virtue writers of modern doctrine should not ignore. It is also a trait as essential to the garrison Army as to the one in the field.

The final Washington legacy is both the most difficult and the most important—subordination of military to civilian control. Dr. Richard Kohn called this the "ultimate greatness of Washington . . . No matter how difficult the times, desperate his own situation, or great his disagreements with Congress or the states, Washington never undermined civil authority or threatened with his vast prestige to overturn the government."

No event so nicely combines his three personality traits of character, persistence and subordination than the often forgotten Newburgh Conspiracy and Washington's response known as the Newburgh Address. Washington's finest hour, his most important legacy to each of you and all his countrymen, was not on the fields of Trenton, Princeton or Yorktown, not during the bitter winter encampments at Valley Forge or Morristown; rather it occurred during those frustrating months between the surrender of Cornwallis and the conclusion of peace. With Congress unable to meet either its pay or pension obligations and with the value of Continental currency and bonds sinking out of sight, a combination of nationalists, financial interests and disgruntled Army officers threatened a coup d'etat.

Washington played his cards carefully. He maneuvered it so that he would address a meeting of officers before the conspirators could act. In what was undoubtedly the most important speech of his career, Washington described how a coup would "overturn the liberties of our country, and . . . open the flood gates of civil discord and deluge our rising empire in blood." He concluded his prepared statement with an appeal for order and temperate action that reminds modern

No generation of soldiers deserved more and received less from their countrymen.

readers of Winston Churchill: "And you will by the dignity of your conduct, afford occasion for posterity to say, . . . had this day been wanting, the world had never seen the last stage of perfection to which human nature is capable of attaining."

As he finished, he reached into his pocket and produced a letter from a congressman who described the difficulties of the situation. As he tried to read it, he paused in bewilderment and, after fumbling in his waistcoat pocket, produced something only a few members of his staff knew about. There was a bit of melancholy in his voice as he explained: "Gentlemen, you will permit me to put on my spectacles, for I have not only grown gray, but almost blind in the service of my country."

The effect of this tender statement in contrast with the civil war, treason and ruination of the ideals for which they fought and which he had earlier predicted, was immediate. Some officers wept. Virtually all recoiled at the idea of a coup d'etat. Washington read the letter, left the meeting, and the conspirators' plans were destroyed by the response to his charismatic leadership.

While I urge you consider and apply to your career all the legacies of Washington's generalship, both tactical and personal, I cannot overemphasize the need for you to follow the last one. No generation of soldiers deserved more and received less from its countrymen than that which fought for our independence. General Washington could easily have justified seizing the reigns of civil authority on grounds of national policy. He had examples from Caesar to Cromwell to imitate. But he refused. He sacrificed the immediate welfare of his officers and men on the altar of republicanism. It was a noble sacrifice. When next time a modern politician cancels the pet weapons system, manpower increase, pay raise or military policy you advocate, recall this final legacy of General Washington. Remain faithful to his ideal of republican virtue—the mythic Roman citizen-soldier Cincinnatus—and ignore the easy way out—symbolized by the classic case of Julius Caesar.

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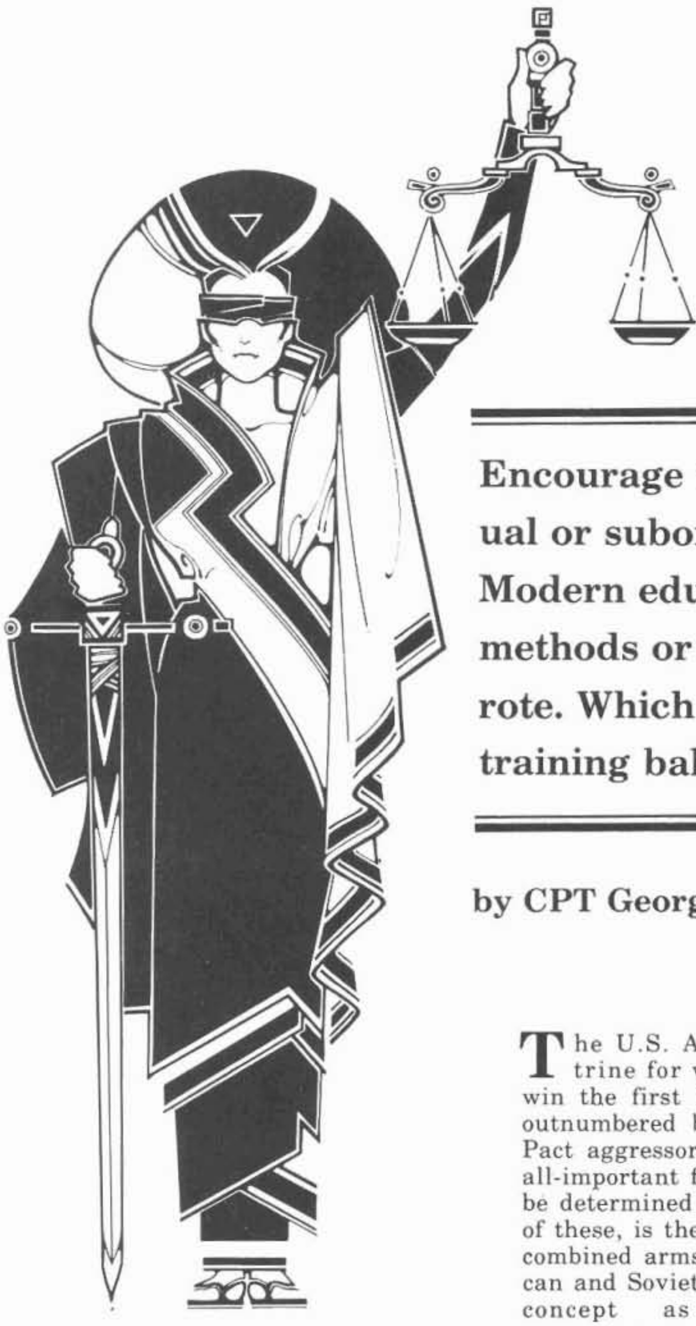
U.S. vs. Soviet Engineer Training



Encourage the individual or subordinate him. Modern educational methods or learning by rote. Which tips the training balance?

by CPT George D. Gagaris

The U.S. Army's current doctrine for war in Europe is to win the first battle despite being outnumbered by a Soviet-Warsaw Pact aggressor. The victor of that all-important first battle may well be determined by two factors. One of these, is the effective use of the combined arms team. Both American and Soviet armies rely on this concept as their tactical cornerstone.

An integral part of this team is the combat engineer, who is located well forward with the maneuver forces. The combat engineer provides these committed forces with essential mobility, countermobility and survivability support.

Another factor that may determine the victor of the next war is the state of individual military training within the two opposing forces. This training poses enormous challenges for U.S. and Warsaw Pact armies, especially with the introduction of sophisticated equipment, weapons and tactics. Without meeting this individual training challenge, other military training goals are difficult to accomplish.

Field Manual 100–5, *Operations*, and military strategists, agree that these factors may be critical elements in determining the victor of the next war. By developing an in-depth understanding of these factors in peacetime, U.S. soldiers at all levels will be better prepared to win the first battle. This may be done by comparing U.S. and Soviet-Warsaw Pact initial entry training for combat engineers.

For U.S. combat engineers, initial entry training is conducted at the U.S. Army Training Center Engineer, Fort Leonard Wood, Mo. The 2d Training Brigade conducts One Station Unit Training (OSUT) for most soldiers entering Career Management Field (CMF) 12. This includes combat engineers, Military Occupational Specialty (MOS) 12B; and bridge specialists, MOS 12C. The atomic demolitions munitions (ADM) specialist, MOS 12E, also trains at Fort Leonard Wood, but after graduation attends the ADM course at Fort Belvoir, Va., to qualify for his MOS.[1]

The purpose of the combat engineer (CE) OSUT program, is to provide a smooth transition from civilian to military life, and to qualify the new soldier in an engineer MOS. The 13-week program includes all program of instruction (POI) elements for basic combat training, as well as MOS 12B and 12C advanced individual training.[2]

The integration of these two POIs permits early introduction of MOS related skills, followed by reinforcement training that ensures soldier proficiency. CE-OSUT uses one unit and one cadre at one station to complete the training necessary to produce a soldier qualified for assignment in an engineer company. This arrangement also allows more accurate assessment of individual ability and potential, and for swift elimination of unproductive soldiers.

The U.S. soldier's normal training day is at least a full 16 hours and is designed to challenge him physically and mentally. Physical readiness training (PRT) is conducted daily and makes up approximately 10 percent of the soldier's total training.

Although PRT is based on a baseline physical training program, the overall program differs slightly from unit to unit because company commanders establish unit goals. The commander also determines the PRT schedule of activities for his unit.[3] A unit's daily PRT will include some sort of exercise, such as the 'daily dozen,' or a grass or rifle drill and a run. Additional physical training comes from road marches of up to 15 miles, negotiating obstacle or confidence courses and playing team sports, all of which toughen soldiers physically and mentally.

Engineer OSUT is basically divided into three phases: survivability, countermobility and mobility. In addition to these phases, the first few weeks of training are spent under a program of "total control," to aid in establishing obedience and discipline. During "total control," a new soldier is constantly supervised by unit drill sergeants who indoctrinate the military way of life. The sergeants also introduce soldiers to general information about the Corps of Engineers and Army combat engineering.

The first five weeks of the training cycle develop the soldier's ability to survive on the battlefield. Instruction during this phase concentrates on physical training, basic rifle marksmanship, obstacles, communications, rigging and first aid.

In the next four weeks, instruction centers on countermobility. This includes studying demolitions, land mine warfare, the M60 machine gun, the M203 grenade launcher and the light antitank weapon. During this phase, soldiers also receive instruction in map reading, communications, engineer tools and physical training.

The last four weeks compose the mobility phase, with soldiers learning offensive skills, such as fixed and float bridging, river assault operations and infantry squad tactics with assault demolitions. Also during the final phase, soldiers participate in a week-long field exercise known as "Engineer Week." The week is devoted to Army Training and Evaluation Program 5–35, *Squad and Platoon Missions*, which allows the soldier to apply new skills in a tactical scenario.

The foundation of the entire CE-OSUT program is its performance oriented, or, "hands-on" training. The soldier learns by doing a task under minimum supervision, and is later evaluated using diagnostic tests that check his progress through military, physical and combat engineer training. These diagnostic tests are: the End of Course Test, given in the seventh week to measure mastery of common soldier skills; the Army Physical Readiness Test, during the 10th week; and the Combat Engineer Test, given in the 11th week to assure overall proficiency before assignment to an engineer unit. A soldier must pass each of these tests to graduate from CE-OSUT and to qualify for either MOS 12B or 12C. ADM specialists study an additional 17 days before receiving MOS 12E.

By comparison, Soviet combat engineer initial military training is quite different. The reasons for this disparity are beyond the scope of this article, however, certain general considerations provide a better understanding of the overall Soviet military training program.

One of these considerations is that the Soviet Union regards military training, and military service, as vital to the nation's existence. This concern is apparent in the 1967 *Law on Universal Military Service*, which provides for "the mandatory conscription of eighteen-year-old males in semi-annual increments, and also governs the system of drafting of young men into the armed forces."[4] The U.S. Army, of course, relies on an all-volunteer force during peacetime and drafts only during mobilization.

Besides conscription, the 1967 *Law on Universal Military Service*

Combat engineer OSUT emphasizes teamwork but differs from Soviet training by also stressing personal achievement. (OSUT photos by Vicky Lipps)

U.S. soldiers learn by doing a task under minimum supervision.

establishes mandatory military training for all Soviet citizens, beginning at age 16. In contrast, there is no mandatory military training for the United States general population.

Finally, consider the upbringing of the Soviet children. These children are taught at an early age to relinquish their individuality to the group and to subordinate themselves to authority. Strict discipline and obedience is developed throughout the school system, and even earlier, in state-owned nurseries and kindergartens.[5] These values set apart the Soviet soldier from his American counterpart, whose *individual* achievements are repeatedly stressed.

The Soviet Union's unique military training cycle can be broken into three phases: civilian premilitary training, in-service training and reserve training.[6] Only the Soviet civilian premilitary training and a part of the in-service training can be considered comparable to U.S. initial entry training. The remainder of Soviet in-service training might be compared to the training performed by our TO&E units. Soviet reserve training is conducted much like training in the U.S. Army Reserve or National Guard. In general, the Soviet Ministry of Defense oversees the entire training process, establishing the goals, political subjects and training programs for the coming year.[7]

Soviet premilitary training is a result of the 1967 *Law on Universal Military Service,* which established "a compulsory system of premilitary training for all young men and women between the ages of 16 and 18, inclusive."[8] The program, begun in 1968, attempts to make the transition from civilian to soldier quicker and easier for new draftees. Premilitary training is general in nature, showing no regard for individual military specialities. The program provides young people with the basic military skills, including awareness of military organization and regulations, use of small arms (including antitank weapons) and civil defense training. They receive 140 hours of training during the standard preinduction program. Training also includes various field exercises lasting from five to 15 days. In addition, the program provides for selected youths to receive special training in their second year. This technical training ranges from driving a truck to operating a radar scope.

The benefits of preinduction training are open to argument, and some Soviet leaders have expressed displeasure with the program.[9] One noticeable problem is that the quality of training varies greatly from unit to unit. Many new soldiers must be retrained in the basic skills upon induction. This retraining process significantly reduces the time available for conducting essential in-service level military training.

Twice each year, a quota of men who have reached their 18th birthday are notified to report for active duty. At this point the commissarists, or draft board, "assign the inductees to the various branches, arms and services of the component forces."[10] These assignments are based on the individual's abilities, job specialties or specialties learned during preliminary training. On a specific day, inductees are taken to their assigned units to begin their active duty, or in-service, training.

The new soldier immediately begins an intensive four week training period known as the "Course of the Young Soldier."[11] This course is used to politically indoctrinate the new soldier and to complete the basic training started during preinduction. The soldier must successfully complete this period of training before he may take the military oath of allegiance and begin the remainder of his military training. The unit officers, warrant officers and noncommissioned officers supervise most of this specialty training, which begins with elementary skill instruction.

In the case of the engineer sol-

PROGRAM OF INSTRUCTION

Combat Engineer One Station Unit Training

Engineer training (mines, tools, rigging, bridging, demolitions and Engineer Week) vehicle operations and maintenance and camouflage	243.5
Combat skills (first aid, tactics, chemical/biological and radiological warfare, foot marching) map reading, squad tactics and bivouac	226
Basic soldiering (inspections, drill, military subjects) and unit taught subjects	132
Weapons (M16A1 rifle, grenades, M60 machine gun, light antitank weapon)	90
Physical Readiness Training (Army Physical Readiness Test, confidence courses, team sports)	85
Administrative time (miscellaneous processing)	70
Testing	20
TOTAL	**866.5 hours**

Training for Soviet engineers (above) is packaged differently from a U.S. engineer's (below), but the biggest difference may be training leadership.

dier, he will be required to "master one specialty and be adequately prepared to perform one or two other related engineering tasks so as to make the engineer special sub-units less vulnerable to losses of trained men."[12] On the average, it will take the soldier six months of training to become proficient in his speciality. There are no distinct breaks in the training to differentiate the progression from elementary skills to more advanced skills. However, sometime during that initial six month period, the Soviet soldier will "graduate," much like his American counterpart does at the end of CE-OSUT.

A typical Soviet training day is similar to one in CE-OSUT.[13] At least six hours of each training day is set aside for military instruction. The training is very repetitious, and learning is by rote. Except for political indoctrination, classroom instruction is minimal, with field training under realistic combat conditions the norm. Soviet instruction relies heavily on simulators instead of actual pieces of equipment. This practice extends the life of actual equipment and keeps repair and replacement costs low.

Physical fitness for the Soviet soldier, as well as for the Soviet citizen, is a part of everyday life. Participation in a formal physical conditioning program starts at age 10, progressing through five stages up to age 60 for men and age 55 for women. Active duty military PRT is geared to prepare soldiers for combat and for the heavy work associated with military service. Training includes unarmed combat, negotiating obstacle courses, various long and short distance runs, gymnastics, swimming, ski racing, forced marches and team sports play. As in the U.S. Army, "each unit commander is responsible for the physical conditioning of his men" and for the functioning of the PRT program.[14]

Although Soviet initial entry training is somewhat different in structure, it is basically on the same level as training conducted for U.S. soldiers in CE-OSUT. The primary impression is that any military training program is only as good as the leaders responsible for it.

Footnotes

1. Information concerning CE-OSUT is based on the author's personal experience.
2. Second Training Brigade (OSUT) *Information Folder*, 2d Training Brigade, Fort Leonard Wood, Mo., p. 8.
3. *Initial Entry Training*, "On the Trail to Better Leadership," 1979, Fort Leonard Wood, Mo., p. 18.
4. Defense Intelligence Agency, *Handbook on the Soviet Armed Forces*, February 1978, p. 5–1.
5. Office of the Assistant Chief of Staff for Intelligence, *Understanding Soviet Military Development*, April 1977, p. 35.
6. DIA, op cit., p. 6–1.
7. David J. Foley and Frank Stone, "The Soviet Ground Forces Training Program," *Defense Intelligence Report*, April 1978, p. 8.
8. DIA, op cit., p. 6–1.
9. DIA, op cit., p. 6–2.
10. DIA, op cit., p. 5–2.
11. DIA, op cit., p. 6–8.
12. C.N. Donnely, 'Combat Engineers of the Soviet Army," *International Defense Review*, Vol. 11, No. 2, April 1978, p. 194.
13. DIA, op cit., p. 1–8.
14. David J. Foley and Frank Stone, "Physical Training of the Soviet Soldier," *Defense Intelligence Report*, April 1978, p. 10.
15. Office of the Assistant Chief of Staff for Intelligence, op cit., p. 36.

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ENGINEER HOTLINE

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Engineers from TF Simoneaux move to new defensive positions during the Ft. Hunter Liggett FTX.

ENGINEERS AS INFANTRY

"Fight as infantry when required"—that is an important secondary mission of combat engineers. It is a wartime mission often assumed at a critical time and at a critical place. But, how often does the combat engineer command a combined arms team in peacetime?

by LTC James M. Cullem

The troops of two engineer battalions duck down deeper into their foxholes as artillery rounds whistle overhead, winging their way toward attacking enemy formations in the open field ahead. The friendly artillery support is comforting to the defenders dug-in on the high ground. But in quick response, enemy guns initiate counterfires causing friendly casualties, decimating troops and equipment still in the open. Amidst smoke and confusion, battle is joined between attacking infantry and defending engineers.

So went the opening event of a 7th Infantry Division field training exercise (FTX) at Fort Hunter Liggett, Cal., a unique FTX in that two combat engineer battalions, reorganized as infantry under a brigade headquarters, were engaged in a "defend" mission.

Concept

The scenario for the FTX reflected a classical battle plan. A friendly nation with which the U.S. had treaty commitments, "Dagon," possessed rich uranium mines coveted by its northern neighbor, "Ur." Ur invaded Dagon, scored significant early successes, and the United States sent the 7th Infantry Division to assist Royal Dagonian forces.

The 1st Brigade, 7th Infantry Division, played the Urian forces, and the 2d Brigade, 7th Infantry Division, played the lead elements of the 7th Division. Since the 7th Division is a "roundout" unit with only two active brigades, no other infantry troops were available to play the Dagonian forces.

LTC Clair P. Gill's 14th Engineer Battalion (Corps) (Combat) of three line companies and a headquarters company was available, as was the divisional 13th Engineer Battalion (Combat) commanded by LTC Joseph A. Simoneaux. The latter unit consisted of two active duty line companies and a headquarters company. The division artillery (DIVARTY), with a doctrinal role as alternate division command post, served as the Royal Dagonian Brigade headquarters.

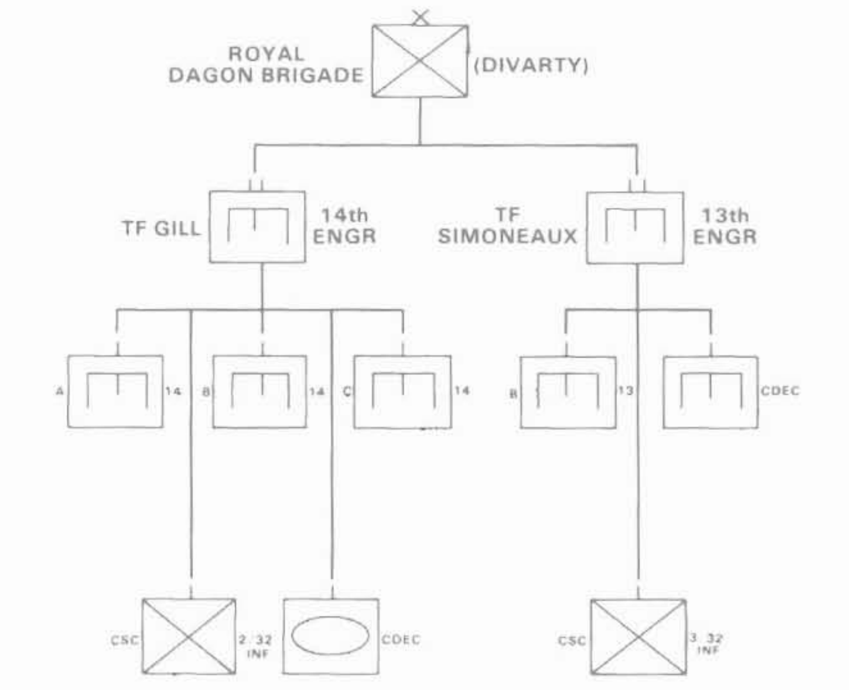
Combat engineers fighting as infantry is not unique. In December 1944, during the Battle of the Bulge, the 1278th, 299th, 35th, and 158th Engineer Battalions fought side by side as infantry defending the approaches to Bastogne. The 51st Engineer Battalion played a key role in holding positions to the northwest of Bastogne and won a Presidential Unit Citation for its performance. These battalions and other engineer units, fighting as infantry, won the praise of Maj. Gen. Troy H. Middleton, the VII Corps commander.[1]

The 14th Engineer Battalion, among others, fought as infantry in Korea, especially during the defense of the Pusan perimeter in 1950.[2] Since the end of the Korean War, however, there has been little opportunity for combat engineers to train as infantry forces. The Hunter Liggett FTX, then, was an unusual engineer training opportunity.

Several field exercises in March and April are described below; TEWTs and reconnaissance were used to improve the command post and to improve camouflage techniques. Several TEWTs (tactical exercises without troops), and a ground and air reconnaissance of the battle area were conducted at Fort Hunter Liggett.

Task Organization

Not equipped with organic TOWs, armor, scouts or mortars, the engineers had to be provided these weapons and personnel to accomplish their mission. The initial task organization is shown in Figure 1. The combat support company (CSC) of the 2/32 Infantry Battalion and a company (−) of tanks from the Combat Development Experimentation Command (CDEC) were attached to the 14th Engineers. The CSC of the 3/32 Infantry and the engineer company of CDEC were attached to the 13th Engineers. A Company, 13th Engineers, remained in its traditional role with the 1st Brigade, the Urian forces. Both engineer battalions were supported by artillery fire support teams (FIST), tactical air control parties (TACP), and forward maintenance support teams. Helicopters from the 1/10th Air Cavalry, Redeye and Vulcan gun sections from the division air defense artillery (ADA) battalion,



Task organization for the engineers-as-infantry FTX.

Preparations

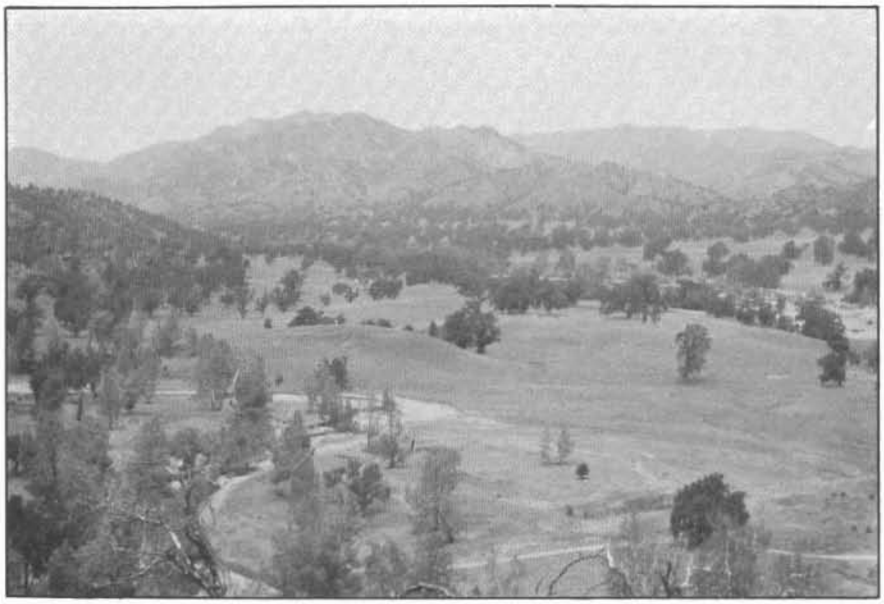
In February and March 1980, the 13th and 14th Engineer Battalions conducted training in infantry tactics and employing artillery and mortar fire, close air support and TOW missiles. Officers from the 7th Division's 3/32 and 2/32 Infantry Battalions, the division Air Force liaison office and DIVARTY provided instruction.

Field exercises in March and April gave both engineer battalions good opportunities to debug their communications procedures, practice rapid deployment of the command post and to improve camouflage techniques. Several TEWTs (tactical exercises without troops), and a ground and air reconnaissance of the battle area were conducted at Fort Hunter Liggett.

and ground surveillance radar (GSRs) teams were also in support. As per battalion SOPs, heavy equipment, trucks and most engineer tools and kits were sent to the field trains area as soon as the battle began.

Each engineer task force was named after its commander. The units were deployed to Fort Hunter Liggett on April 30 and the task forces were organized in place by May 3.

fighting positions, aerial drops of barrier materials to the initial positions of both engineer battalions were made by C130 aircraft on May 4. The airdrop provided excellent training in Air Force resupply operations in the forward combat zone. These materials were used to construct obstacles forward of initial task force positions. Organic engineer dozers and backhoes dug in the tank and TOW positions. Close coordination between engineer and attached infantry and armor troops yielded optimum weapon, obstacle and fighting position interaction.


The Ft. Hunter Liggett area of operations.

The Battle Area

The terrain at Fort Hunter Liggett consists largely of treeless plains and open valleys which provide maneuver room for small tank forces. There are also areas of rocky mountains, grassy hills, lakes, streams and wooded areas conducive to dismounted infantry operations. Though the total size of the maneuver area was limited, it was nonetheless ideal for the FTX. Both task forces (TF) were to defend well forward in their sectors. TF Gill, the larger, was on the left flank defending a sector five kilometers wide which included the major mechanized avenues of approach. Smaller TF Simoneaux defended a narrower sector, two and one-half kilometers wide, on the right flank with higher and more mountainous terrain. The terrain in both task force sectors provided a series of natural delay positions.

Although restricted access to the battle area prior to the exercise precluded the installation of a maximum number of obstacles and

Attack, Counterattack

The DIVARTY's live-fire preparation on May 5 was made as realistic as possible so the troops could experience friendly artillery fire passing overhead and impacting to the front. The positioned engineers had full view of the artillery preparation and gained a heightened appreciation for the effectiveness of artillery and the need for well built foxholes with overhead cover. Following the artillery preparation, Urian forces began daylight probes along the entire Royal Dagon Brigade front. Friendly ambush patrols, outposts, and CSC scouts screening in front of Dagon positions proved invaluable in "seeing the battlefield" during the early engagements. Also, the initial placement of obstacles and battle positions paid large dividends in tilting initial combat ratios in favor of the defenders.

However, a battalion-sized night assault against the Dagon left flank company was successful after a long and confusing battle. Team A, TF Gill, withdrew under pressure and the flanking maneuver by the enemy penetrated several kilometers into friendly territory. At the same time, on the Dagon right, the TF Simoneaux's CDEC was attacked by dismounted infantry and an airmobile assault force, but the company was able to hold its position. In addition, an artillery attack on the TF Gill tactical operations center (TOC) resulted in personnel losses to the battalion staff.

At this critical time, the Dagonian Brigade commander (DIVARTY commander) ordered a counterattack. TF Tidwell, led by the commander, CSC, 2/32 Infantry, was formed. From all the scouts of both the 2/32 and 3/32 CSCs and the CDEC tank company (eight tanks) which had been originally attached to B Company, TF Gill. A platoon of engineer troops on 5-ton trucks was detached from C Company, TF Gill. This mobile force was assembled and in position by 0400 hours. TF Tidwell was to thrust across the TF Gill sector behind the strongly held B and C Company positions and strike the enemy column. The counterattack was launched at 0445 hours supported by artillery, attack helicopters and tactical aircraft. It was a total success.

Early Lessons Learned

The first major engagements of the "war" provided some very useful lessons. Probably the most significant was the need to anticipate the unexpected, and look for it to happen at night. Although the low valley approaches in the center were obviously the major avenues of approach, the enemy forces massed against the flanks in a night attack and bypassed the strongly defended center. Only a dogged defense and a preplanned counterattack saved the day.

The active defense envisioned in mechanized warfare requires quick lateral and reinforcing movement of troops on the FEBA (forward edge of the battle area). Dismounted infantry, however, have a difficult time disengaging, and cannot move laterally across the battlefield quickly enough to react to a penetration. As opposed to the current philosophy of mechanized warfare where most available forces are committed to likely avenues of approach, an engineer battalion, reorganized as dismounted infantry, ought to keep a reserve of at least one platoon. Trucks or other vehicles must be available for transportation, and supporting arms such as scout jeeps, armor, and artillery need to be earmarked once the reserve is committed.

The inherent vulnerability of the TOC to artillery fire became evident the first day. The best alternate TOC is the combat support company headquarters because the CSC has adequate radio communications and usually has the TOC backup mission in an infantry battalion. Care must be taken to conceal the TOC's location from the enemy. TOCs should be moved at least once every 12 hours. It must be well dug in and be located away from hilltops, crossroads or other locations likely to be targeted by enemy artillery. The terrain should be used to mask signal emissions.

Action The Second Day

On the second day of the war, the engineer troops engaged in a delaying action all along the front. Despite Dagonian successes the previous night, Urian forces again penetrated the left flank and continued to advance. The rate of movement of these forces set the pace of the delay as TF Gill sought to avoid envelopment on the left. Contact between TF Gill and TF Simoneaux was maintained during the delay and precluded Urain forces from slipping between the two units. Because TF Simoneaux's movement was slowed by the rugged terrain, an airmobile operation was used to move the engineers from their second to their third position.

It was during this phase of the operation that Murphy's Law came into full play and a most significant communications problem developed. The loss of the TOC (and switchboard) on the first day, coupled with a defensive battle that turned into a delaying action, caused a complete breakdown of communications. During movement, engineer company teams were unable to tie into pre-laid wire and FM communications were severely hindered by the terrain, by unskilled operators, and by a lack of radios at the company level. Radio communications were lost—laterally and vertically—within TF Gill for a period of about six hours. The direct consequence was loss of control and the opening of serious gaps in the defensive positions along the secondary line of defense.

More Lessons

Units must establish contact with adjacent units on the ground, and must insure radio or wire communications to higher headquarters are maintained at all times. Alternate means of communications, pre-established rally or contact points, use of pyrotechnic signals, etc., must also be agreed to beforehand. Since cryptographic key changes can also cause serious radio problems, they must be anticipated and problems corrected quickly. Every unit must habitually encode its grid coordinate position and send it to higher headquarters. *No* unit should leave a position, especially a critical road block or fortification, until physically replaced by the relieving unit. Fatigue, both physical and mental, took its toll and was reflected in leader's decisions and in the troop's performance. Leaders must find time to sleep and to obtain rest for their men during lulls in the battle or the troops will be close to ineffective after 72 hours of combat.

Serious problems with wire and FM communications led to control problems and defensive gaps.

The Last Day

May 7 was devoted to improving the final defensive line and coordinating for the passage of lines by the 2d Brigade, 7th Infantry Division. More live artillery was fired at 1600 hours to prepare the battlefield. The actual passage of lines took place between 2030 and 2200 hours. Despite extensive coordination during the day, several friendly units exchanged gunfire, a testimony to the difficulty of accomplishing such a maneuver at night in the face of the enemy.

After the passage of lines, TF Simoneaux was reorganized. It released the CDEC engineers and other attachments and placed B Company, 13th Engineers, in direct support of 2d Brigade, 7th Infantry Division. TF Gill also released its attachments and reverted to its corps engineer role. The 13th Engineer Battalion, with A/13th direct support to the 1st Brigade (Urian) and B/13th direct support to the 2d Brigade (7th Infantry Division), remained in the exercise until May 9 accomplishing missions as combat engineers.

Conclusions

Historically, engineer battalions have been reorganized as infantry only when the tactical situation reached a crisis stage. Little in the way of armor, artillery, antiarmor or air support assets are likely to be available. Nevertheless, engineers must know how to employ these assets as a combined arms team. They must continue to apply their special expertise in maximizing the defensive capabilities of the terrain and utilizing available obstacles to optimize the effectiveness of weapons systems. Engineer troops must be capable of fighting a delaying action, whether supporting arms are available or not.

Engineers fighting as infantry are likely to be thinly stretched and opposed by superior forces. Nevertheless, they must somehow retain the ability to counterattack. Contrary to traditional engineer SOPs, enough vehicles must be kept close to the FEBA so troops can move laterally, reinforce or counterattack quickly. Several 5-ton dump trucks at the right time and place can mean the difference between winning and losing.

Friendly forces can expect plenty of incoming artillery so they should be well dug in with covered and concealed positions with protected routes of egress and ingress. This fact warrants a second look at typical engineer reorganization SOPs which program the heavy construction equipment to move to the rear. A better tactic might be to retain the equipment up front until the very last minute to dig positions and create obstacles. Equipment would then withdraw only as far as the next positions and go to work again. Engineer equipment used in this manner can have a great multiplier effect upon the combat power of the fighting forces.

Since infantry operations lend themselves to night fighting in rugged terrain, engineer troops must train in that type of an environment.

basis. The set-piece nature of the FTX allowed it to work well, but a more free-flowing tactical situation could easily result in serious control problems.

The FTX was a rewarding and challenging experience for the engineers. They had the opportunity to plan and coordinate for the exercise, and to fight as infantry under the direction of a brigade headquarters. Most of the significant lessons learned have already been discussed above. However, two unresolved problems are worthy of a final note.

A price is paid in over all combat effectiveness when engineers are diverted from their primary combat engineer role to perform their secondary infantry role.

If the engineer battalion receives an attachment of armor, it must also receive adequate maintenance and support packages. During the FTX, failure to provide such a package led to fuel or maintenance-related losses of 50 percent of attached armor assets within 72 hours.

From a logistical standpoint, the organization of field trains and combat trains was successful. The field trains contained the bulk of S1/S4 and maintenance assets while the combat trains contained only those S1 and S4 elements needed forward to control the flow of supplies, respond to equipment recovery requests, and to coordinate the flow of replacements and evacuate casualties and refugees. However, the exercise ran too short to determine whether the train's organization, provided from organic assets, could sustain the battalions over an extended period of time. For the most part, the engineers supplied themselves from their initial three-day basic load of ammo and fuel, and required little actual resupply. In addition, as is often the case in training, transportation and logistical capabilities in support of an actual defensive obstacle plan were not tested. Provided that the trucks of the engineer battalion remain available in the battle area, engineers should be able to handle the resupply requirements of an infantry operation.

Operating as part of a brigade requires coordination on a continuous basis.

Unresolved Problems

1. Communications remain an unsolved problem. By TO&E (table organization and equipment), there are insufficient men and materials to establish telephone communications from battalion to company. The use of wire from company to platoon and from platoon to squad is, however, feasible under current TO&E. Secondly, the currently available radio teletype systems are extremely difficult to put into operation and to maintain. It is recommended that engineer units be augmented with additional radios and communication assets for the infantry mission.

2. A price is paid in overall combat effectiveness when engineers are diverted from their primary combat engineer role to perform their secondary infantry role. Such a reorganization in combat should take place only after the commander has fully considered the consequences of losing engineer combat multipliers. As noted in Hugh M. Cole's *History of the U.S. Army in World War II, the Ardennes: Battle of the Bulge:*

"The magnificent job which Maj. Gen. Middleton later ascribed to the engineers credits them in their role as infantry . . . Nonetheless, the story of the Ardennes barrier lines does make clear that use of engineers in their capacity as trained technicians often paid greater dividends than their uses as infantry, and that a squad equipped with sufficient TNT could, in the right spot, do more to slow the enemy advance than a company armed with rifles and machine guns."[3]

However, in future wars there still will be occasions when engineers will reorganize and fight as infantry. Whether the action is squad or brigade-sized, combat engineers must remain as capable and as motivated as their predecessors to live up to the motto "Essayons" (Let Us Try) . . . to fight, and to win.

FOOTNOTES

1. *U.S. Army in World War II, European Theater of Operations, The Ardennes: Battle of the Bulge,* Hugh M. Cole, Office of the Chief of Military History, Dept. of the Army, Chap XIV.
2. *U.S. Army in the Korean War, South to the Naktong, North to the Yalu,* Roy E. Appleman, Office of the Chief of Military History, Dept. of the Army, Chap XXIIV, XXIV.
3. Ibid, Cole, page 329.

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THE GERMAN TERRITORIAL ARMY

An important link between West Germany's military and civilian spheres, and a vital wartime asset to allied forces.

by LTC Hubertus Dunschen

On the face of it, many a soldier in the U.S. Army is tempted to regard the German Territorial Army as a kind of German Army National Guard. Mission and organizational structure, however, are not comparable. Since the German Territorial Army has—among other things—a mediating function with regard to allied NATO forces in Germany, each American officer who is either stationed in Germany or a member of a reinforcement unit would be well advised to familiarize himself to some extent with the characteristics of the German Territorial Army.

Army Structure No. 4

The German Army is composed of three major elements: the Army Field Forces (assigned to NATO), the Territorial Army (under national command) and the General Army Office (national command in charge of central Army agencies and schools). In the late 1970s, following intensive structural studies, the German Army began to adopt a new organization, known as Army Structure No. 4.

The basic organizational structure of the engineers in the Army Field Forces was retained; i.e., one (organic) armored engineer company in each brigade, one engineer battalion per division and one engineer command per corps. The commanders of these regular units at the same time serve as engineer commanders within their respective major formation and as advisors in engineer-related matters to their next higher commander.

Nevertheless, the internal structure, organization and equipment of both engineer battalions and engineer companies were changed and adapted to the overall concept of Army Structure No. 4. All engineer units are fully mobile with the brigade engineers being armored.

The engineers of the Army Field Forces are employed on the battlefield in a direct combat support role. In keeping with the defense concept of the German Armed Forces, their main mission is to impede enemy movements within the scope of operations conducted by the major formations sponsored by them.

The Territorial Army

When setting the objective for the new Army Structure No. 4, the chief of staff of the Army considered it imperative to strengthen the Territorial Army and to make it better suited to fulfill its many missions. Those main tasks of the Territorial Army are:

1. To act as mediator between the military and civilian spheres.
2. To maintain the freedom of operation for NATO forces in the territory of the Federal Republic of Germany by means of:
   - rear area protection
   - military movement control measures
   - supporting river crossing operations
   - NBC defense measures
   - damage repair
   - explosive ordnance disposal
   - psychological defense measures

- establishing and operating communications

Furthermore, the Territorial Army is:

- to assume special command and control, and support tasks
- to ensure readiness of personnel, logistics as well as medical care and support
- to assist in civil defense operations

Thus, the German territorial commander renders direct support to the NATO commander to carry out his mission.

To accomplish its comprehensive mission, the Territorial Army makes use of its territorial headquarters organization, which covers the entire territory of the Federal Republic of Germany, and, its territorial forces which are used for mobile employment.

The Territorial HQ

The territorial headquarters organization is adapted to both the political structure of the Federal Republic of Germany and to the NATO command structure in Central Europe. The organization consists of Territorial Command Schleswig-Holstein, the Territorial Northern Command and the Territorial Southern Command.

Subordinate to these Territorial Commands are the Military District Commands (WBK), which in turn have Military Region Commands (VBK) as subordinate agencies, which in turn command Military Subregion Commands (VKK).

Each Military District has a Military District Administrative Office (WBV) as higher agency of the Federal Armed Forces Administration. Subordinate to these Military District Administrative Offices are a number of Garrison Administrative Offices (STOV) as local agencies of the Federal Armed Forces Administration. This organization of the Federal Armed Forces Administration, however, is not part of the Territorial Army. It is independent of the armed forces and is to cooperate with them to fulfill administrative tasks related to the Bundeswehr. Figure 1 shows the levels of cooperation between the NATO forces, the Territorial Army, the Federal Armed Forces Administration and the various levels of state and local government in the Federal Republic of Germany.

German Territorial Army

Levels of Command & Cooperation

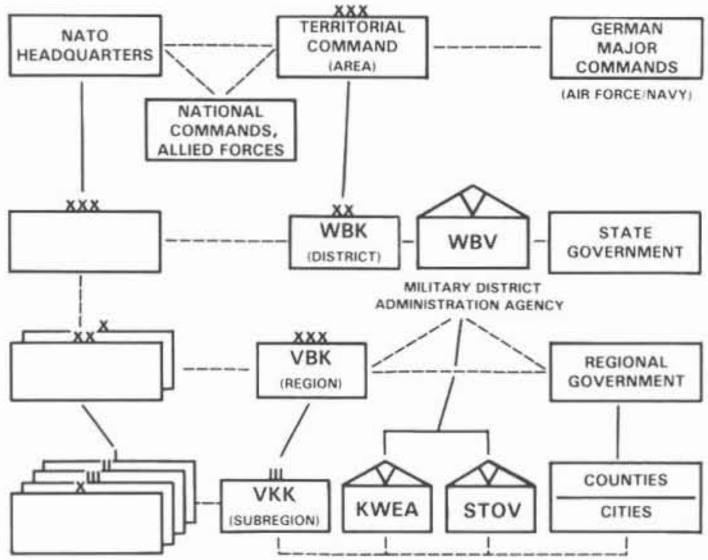


Figure 1.

To ensure smooth cooperation in wartime as well there is a liaison organization of the Territorial Army. Figure 2 illustrates the complexity of both tasks and cooperation even at the lowest command level of the Territorial Army, the Military Subregion Command (VKK), which is shown as the hub of the liaison network. The same applies to VBK and WBK with respect to their allocated levels of cooperation.

Figure 2.

Possible operational links of the German Territorial Army, subregional level.

Territorial Forces

To accomplish the second essential part of its mission, to maintain the freedom of operation of NATO forces on the territory of the Federal Republic of Germany, the Home Defense Force and several territorial service support commands are placed under the command of the Territorial Army. Both combat power and the number of home defense units have considerably increased within the framework of Army Structure No. 4. While almost exclusively consisting of unarmored units in the past, mechanized armored units of the Home Defense Force have now been activated for rear area security/rear area protection.

In addition, the Territorial Army

commands a number of command and control, combat support and logistic elements as well as special agencies and organizations to fulfill the following tasks:

- military movement control
- engineer support, including area damage control
- NBC defense measures
- communications support
- psychological defense operations
- enforcement of military law and order
- POW
- military geographic and geophysical support
- logistic and medical support for GE and assistance to allied forces
- personnel mobilization and replacement
- public relations
- procurement/use of civilian services/support
- support of civil defense organizations
- information compilation
- liaison

While the Territorial headquarters organization is already fully operational in peacetime, the majority of Territorial Forces consist of cadre-strength or partially cadre-strength units which can be brought up to strength with reservists within a relatively short period of time. Their equipment has already been pre-positioned at mobilization bases.

Host Nation Support

The tasks listed above to some extent coincide with individual host nation support (HNS) functions. The German Territorial Army is therefore an essential carrier, as well as coordinator and mediator, for HNS in peacetime and wartime. The allied forces will submit their requirements within the scope of HNS to the appropriate agencies of the Territorial Army. In this connection, military support is not the main objective of wartime host nation support (WHNS), but rather the provision of both materiel support and services through access to commercial resources.

The subject of wartime host nation support is many-faceted and complex and shall not be detailed here. The roots of WHNS are to be found in the NATO Long-Term Defense Program, and it is designed to make possible the fast redeployment of reserve forces to Europe as well as to increase the conventional deterrence posture of the alliance.

To share the burden and to determine specific commitments, an agreement on WHNS was signed by the United States and the Federal Republic of Germany on April 15, 1982. In accordance with the agreement, Germany assumes considerable capital expenditures and operating costs and has committed itself to provide personnel (military and civilian) on a permanent basis for WHNS tasks already in peacetime. In addition, more than 90,000 men will be made available to support U.S. forces in wartime.

An umbrella organization, to be set up in peacetime, is to assume command and control, logistics and training of the German support forces.

Territorial Army Engineers

Engineer forces form an organic part of the Territorial Forces. It must be emphasized that the engineers of the Territorial Army have also been assigned combat support tasks rather than construction tasks as some elements of the U.S. Army Corps of Engineers. These engineer tasks are primarily related to operations in the rear area, behind the corps. But is it also con-

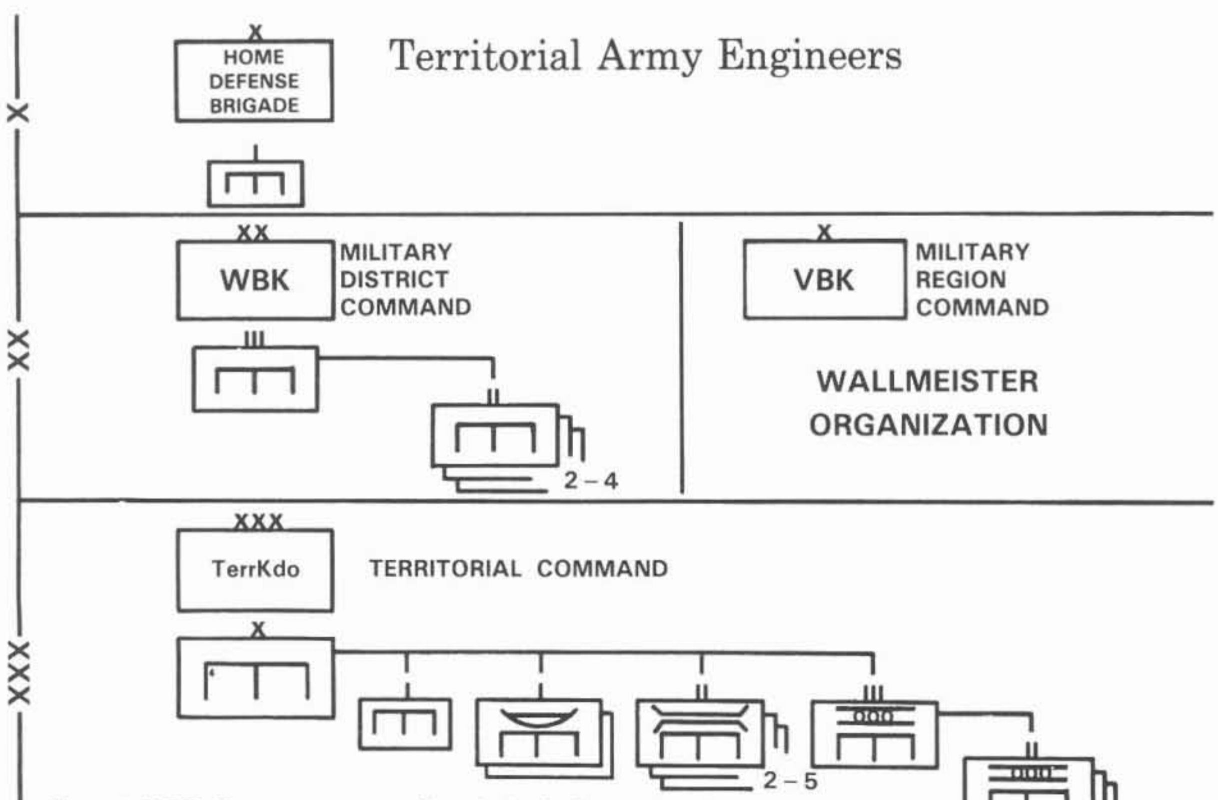


Figure 3. NOTE: There are no topographic units in the German Army's Corps of Engineers. Topo is a special service with the artillery.

ceivable that Territorial Army engineers will be employed in direct support of engineer forces in the Corps area of operations.

The Territorial Northern (GTNC) and Southern Command (GTSC) now have one engineer command each. The commanders of these engineer commands at the same time act as GTNC and GTSC engineer respectively. They are responsible for the employment of all engineer forces of the respective Territorial Command, including necessary preparatory measures. They work closely with the engineer commanders and/or engineer special staff sections of NATO headquarters and the high commands of allied forces as well as with civilian authorities.

The engineer command has the capabilities to ensure the crossing of wide waterways by employing its float bridge battalions and river engineer companies once fixed crossing sites can no longer be used. To ensure crossing of the Rhine River, these battalions and companies are equipped with special river crossing means and bridging equipment which meet the specific requirements of the Rhine.

Relying on its pipeline engineer group as a unit with a logistic mission, the Engineer Command operates fixed facilities and installations of the NATO pipeline system and repairs damaged or destroyed pipeline facilities.

Since the organization of the Territorial Command Schleswig-Holstein (TC S–H) is somewhat different, it shall not be detailed here. The Military District Commands have one engineer group each whose primary mission comprises:

- repairing damage along communications lines and defense-essential infrastructure,
- emplacing barriers, and
- supporting other forces by means of field fortifications.

The Home Defense Brigades as well as the brigades of the Army Field Forces have one organic engineer company each to render direct combat support to the brigade.

The Denial Engineers

The denial engineers (Wallmeister) represent a special engineer organization within the Territorial Army.

The Military Region Commands have varying numbers of denial engineer teams. They conduct reconnaissance with respect to barriers and assist in the installation, control and maintenance of barriers and prechambered targets (target folders). They compile and update engineer intelligence data and advise the units in all matters regarding the planning of barriers and movements.

These denial engineers are experienced senior NCOs of the engineer forces who have received special training for their mission. They carry out their mission in one or several counties *(Landkreise)* and cooperate with the units earmarked for this sector or employed in it.

Since they often hold the same position for many years, and since they frequently are native to their specific area of responsibility, they are very much familiar with both aspects of the terrain and the local population.

Their assistance in preparing engineer intelligence data (surveys of rivers, waterways and adjacent terrain) and their involvement in barrier infrastructure activities already in peacetime (barrier installation/prechambered targets) makes them local experts who are often important advisors to the engineers regarding the fulfillment of their mission.

An engineer staff officer in the Military Region Command exercises command and control over the denial engineer teams.

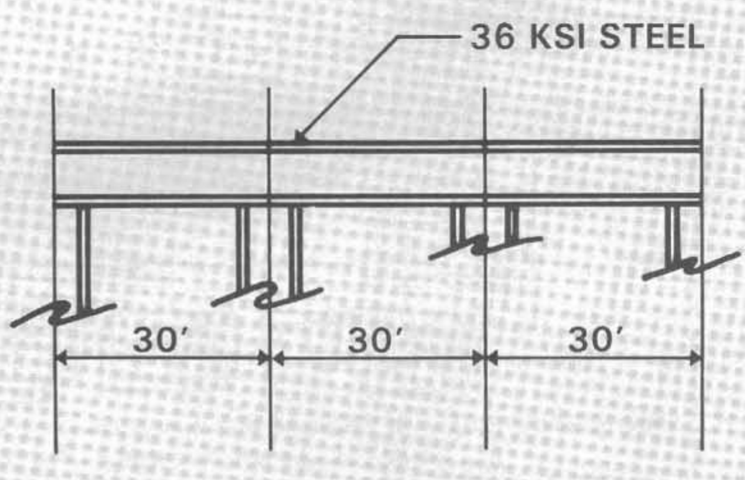
The Territorial Army, then, is an extensive organization with a wide range of missions. In wartime, it will provide vital assistance to allied forces.

LTC Hubertus Dunschen is a graduate of the University of Cologne and the German Army's Officer School and Engineer School. He has commanded NBC defense, combat engineer and armored engineer companies; served as a battalion and corps operations officer and commanded the 5th Engineer Battalion. LTC Dunschen is the German Army liaison officer to the U.S. Army Engineer School and to MERADCOM at Ft. Belvoir, Va.

The ENGINEER Problem

The factored design load for the upper level floor of a recreation center was calculated to be 1.5 kips per foot. The floor design requires the placement of a continuous beam for 90 feet. The spacing of the supporting columns will enable third-point support of the beam. Adequate lateral bracing will be provided.

Select the most economical wide flange member and calculate the maximum deflection in inches.



Solution on page 41

The Engineer Calculator

Mini-computer capabilities & designed specifically for combat engineers.

by John M. Deponai

Combat engineers perform a tremendous variety of engineer missions. To complete them successfully, engineers often must make complex calculations or follow lengthy algorithms to determine logistical requirements. This fall, the Engineer Programmable Calculator, an experimental training device developed by the U.S. Army Construction Engineering Research Laboratory (CERL) for the Engineer School, will make its debut as a supplement to FM 5-34, *Engineer Field Data*. The benefit of such a device is not in its use as a calculator, but in its use as a powerful, hand-held computer.

Background On Development

Based on feedback from active Army engineer units and detailed analysis by the Engineer School, CERL identified military engineering applications that were suited to automation, and those that if automated, would be highly valued by field troops.

The utility of the particular programs CERL selected was based not only in their specific benefit, but also in their example as to what is possible using an electronic medium like the programmable calculator.

It is hoped that exposure to the programmable calculator will eliminate some of the bias against "thinking automation." Automation is coming! The choice is to be in the vanguard of the inevitable, or to sit back complacently awaiting the day when someone asks, "How come we didn't think of this before?"

Preparing for the future takes a lot of imagination, energy, frustration and initiative. It is impractical to wait for technology to stabilize; the world is changing faster than ever before. New and better hardware and software are forever on the horizon.

The Hardware

The Engineer Programmable Calculator is a Hewlett Packard (HP)-41cv calculator accompanied by a specially programmed, plug-in, read-only-memory (ROM) module, labeled MILENG1/UTIL. This module is smaller than a matchbook, yet can store 8,000 bytes of program information.

The HP-41 has room for four such ROMs—32,000 bytes of information—plus the 2,200 bytes of built-in, read-write memory standard on the HP-41cv model. The HP-41 also has a growing family of peripherals, including a card reader, an optical wand and a thermal printer.

The HP-41 can display alphanumerics. Twelve characters can fit onto the display window and up to 24 characters can be "scrolled" across the window. The alpha characters are printed in blue on the front part of the keys and the alpha mode is accessed simply by pressing the ALPHA key.

Users can assign programs or functions to almost any key on the keyboard; when the calculator is in the user mode (accessed by pressing the USER key), the program assigned to that key will be executed immediately. This is especially convenient when running the same program a number of times.

On the whole, this calculator is very user-friendly. Those who prefer algebraic notation over Reverse-Polish Notation (RPN) may be a little dismayed, but are advised that the programs stored on MILENG1/UTIL require only that the user be able to answer "Y" or "N" and to input values as requested by the program. It is not necessary to know RPN to use the MILENG1/UTIL programs.

Synergy

A major purpose of the demonstration Engineer Programmable Calculator is to show field troops how they can become intelligent partners with the research community in managing change, and not be victims of "the ivory tower."

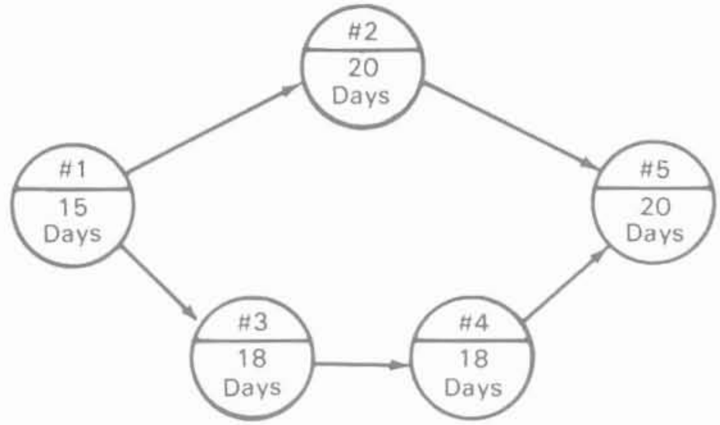
How the programming conventions used in the Engineer Programmable Calculator evolved, demonstrates how synergism can result from sharing ideas with the

The HP-41c Engineer Programmable Calculator; plug-in, read-only- memory (not visible); card reader (inserted into top of calculator); and thermal printer.

```
            XEQ    "CPM"
TOTAL #ACTIVITIES=?
               5.     RUN
ACTIVITY#=?
               1.     RUN
DURATION=?
              15.     RUN
PRED. ACT=?
               0.     RUN
ACTIVITY#=?
               2.     RUN
DURATION=?
              20.     RUN
PRED. ACT=?
               1.     RUN
PRED. ACT=?
               0.     RUN
ACTIVITY#=?
               3.     RUN
DURATION=?
              18.     RUN
PRED. ACT=?
               1.     RUN
PRED. ACT=?
               0.     RUN
ACTIVITY#=?
               4.     RUN
DURATION=?
              18.     RUN
PRED. ACT=?
               3.     RUN
PRED. ACT=?
               0.     RUN
ACTIVITY#=?
               5.     RUN
DURATION=?
              20.     RUN
PRED. ACT=?
               2.     RUN
PRED. ACT=?
               4.     RUN
PRED. ACT=?
               0.     RUN
ACTIVITY#=?
               0.     RUN
ANY CHANGES (Y/N)?
N                     RUN
 ENTER ENDING ACTIVITIES
END ACT.#=?
               5.     RUN
END ACT.#=?
               0.     RUN
START ACT.#=?
               1.     RUN
SEE KEY (Y/N)?
Y                     RUN
```

THE CPM PROGRAM

Simple Network



Cut & Paste Solution

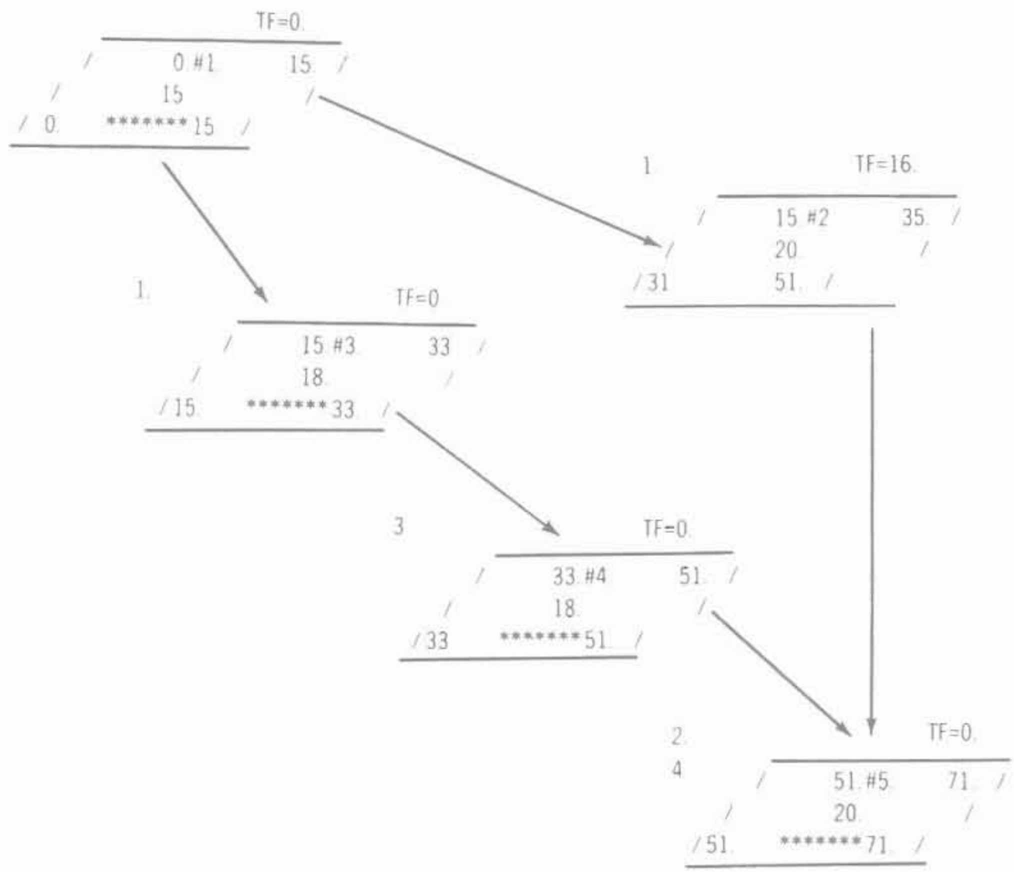


Figure 1. The calculator can be used for CPM project control. Data from the printout (left) is pasted into position (above).

*Figure 2. The following information allows you to program the HP-41cv calculator to provide data regarding preparation of road craters (types). First, execute the built-in routine called "size," then enter "40" to configure the calculator's memory for the program. The program immediately below is an input/output subroutine (*F) which must be entered first. Then enter the road cratering main program (Crater).*

Input/output Subroutine

```
PRP "*F"

01•LBL "*F"
02 7

03•LBL 04
04 CF IND X
05 DSE X
06 GTO 04
07 CF 00
08 RTN

09•LBL "*S"
10 "RESIZE>"
11 1
12 -
13 SF 25
14 RCL IND X
15 FS?C 25
16 RTN
17 FIX 0
18 1
19 +
20 XEQ "*0"
21 STOP

22•LBL "*I"
23 XEQ 13
24 STO 25
25 RDN
26 STO 26

27•LBL 08
28FS? 09
29 RCL IND 24
30 "⊦="
31 FS? 09
32 ARCL IND 24
33 "⊦?"
34 CF 22
35 TONE 5
36 AVIEW
37 STOP
38 FS? 22
39 GTO 01
40 FC? 09
41 GTO 00
42 ISG 24
43 STO X
44 RTN

45•LBL 00
46 XEQ 14
47 GTO 08

48•LBL 01
49 "MUST BE"
50 RCL 25
51 X<=Y?
52 GTO 02
53 "⊦>"

54•LBL 03
55 XEQ "*0"
56 GTO 00

57•LBL 02
58 "⊦<"
59 RDN
60 RCL 26
61 X<Y?
62 GTO 03
63 RDN
64 STO IND 24
65 ISG 24
66 STO X
67 RTN

68•LBL "*0"
69 "⊦<"
70 ARCL X

71•LBL "*D"
72 TONE 8
73 TONE 9
74 AVIEW
75 FS? 55
76 PSE
77 FC? 55
78 STOP
79 RTN

80•LBL "*Y"
81 XEQ 13

82•LBL 10
83 "⊦(Y/N)"
84 SF 10
85 XEQ 05
86 ASTO X
87 "Y"
88 ASTO Y
89 X=Y?
90 RTN
91 CF 10
92 "N"
93 ASTO Y
94 X=Y?
95 RTN
96 XEQ 14
97 GTO 10

98•LBL "*A"
99 XEQ 13

100•LBL 09
101 CF 10
102 "⊦="
103 FC? 09
104 GTO 05
105 ARCL IND 24
106 ISG 24
107 STO X
108 ARCL IND 24
109 DSE 24
110•LBL 05
111 "⊦?"
112 CF 23
113 AON
114 TONE 5
115 AVIEW
116 STOP
117 AOFF
118 FS? 10
119 RTN
120 FS? 23
121 GTO 07
122 FS? 09
123 GTO 06
124 XEQ 14
125 GTO 09

126•LBL 07
127 ASTO IND 24
128 ASHF
129 ISG 24
130 STO X
131 ASTO IND 24
132 DSE 24

133•LBL 06
134 CLA
135 ARCL IND 24
136 ISG 24
137 STO X
138 ARCL IND 24
139 ISG 24
140 STO X
141 RTN

142•LBL 13
143 ASTO 20
144 ASHF
145 ASTO 21
146 ASHF
147 ASTO 22
148 ASHF
149 ASTO 23

150•LBL 14
151 CLA
152 ARCL 20
153 ARCL 21
154 ARCL 22
155 ARCL 23
156 RTN

157•LBL "*C"
158 0
159•LBL 11
160 STO IND Y
161 ISG Y
162 GTO 11
163 RTN

164•LBL "*R"
165 .99
166 +
167 INT
168 RTN

169•LBL "*P"
170 SF 12
171 "END PROGRAM"
172 TONE 8
173 TONE 9
174 AVIEW
175 CF 12
176 ADV
177 ADV
178 ADV
179 ADV
180 RTN
181 "26/01"
182 END
```

Main Road Cratering Program

```
PRP "CRATER"

01•LBL "CRATER"

02 40
03 XEQ "*S"
04 CF 00

05•LBL 01
06 FIX 1
07 31.039
08 XEQ "*C"
09 31
10 STO 24
11 "CRATER LENGTH, ("
12 "⊦FT)"
13 999
14 ENTER↑
15 3
16 XEQ "*I"
17 "USE CRATER CHAR"
18 "⊦GE"
19 XEQ "*Y"
20 FS? 10
21 ST 00

22•LBL 03
23 "CRATER TYPE:"
24 XEQ "*D"
25 "HASTY"
26 XEQ "*Y"
27 FS? 10
28 GTO 11
29 "DELIBERATE
30 XEQ "*Y"
31 FS? 10
32 GTO 21
33 "RELIEVED FACE"
34 XEQ "*Y"
35 FS? 10
36 GTO 31
37 GTO 03

38•LBL 11
39 XEQ 81
40 33
41 STO 24
42 "CRATER DEPTH, (F"
43 "⊦T)"
44 15
45 ENTER↑
```

```
46 7.5
47 XEQ "*I"
48 RCL 33
49 1.5
50 /
51 STO 34
52 10
53 *
54 XEQ "*R"
55 STO 35
56 40
57 /
58 INT
59 RCL 32
60 *
61 STO 36
62 40
63 *
64 STO 38
65 RCL 35
66 RCL 32
67 *
68 —
69 CHS
70 STO 37
71 RCL 38
72 +
73 STO 39
74 ADV
75 FIX 0
76 "#HOLES"
77 RCL 32
78 XEQ "*0"
79 FIX 1
80 "HOLE DEPTH, FT"
81 RCL 34
82 XEQ "*0"
83 FIX 0
84 "EXPLOSIVE, LBS/"
85 "⊢HOLE"
86 RCL 35
87 XEQ "*0"
88 FS? 00
89 GTO 15
90 GTO 79

91•LBL 15
92 "#CRATER CHG"
93 RCL 36
94 XEQ "*0"
95 "TNT,LBS"
96 RCL 37
97 XEQ "*0"
98 GTO 79

99•LBL 21
100 XEQ 81
101 2
102 /
103 INT
104 1
105 +
106 STO 34
107 RCL 32
108 —
109 CHS
110 STO 35
111 RCL 34
112 2
113 *
114 +
115 STO 36
116 40
117 *
118 STO 39
119 ADV
120 FIX 0
121 "#7FT.HOLES"
122 RCL 34
123 XEQ "*0"
124 "#5FT.HOLES"
125 RCL 35
126 XEQ "*0"
127 FS? 00
128 GTO 23
129 GTO 79

130•LBL 23
131 "#CRATER CHG"
132 RCL 36
133 XEQ "*0"
134 "PRIMER:TNT,LBS"
135 RCL 35
136 XEQ "*0
137 RCL 39
138 RCL 35
139 +
140 STO 39
141 GTO 79
142•LBL 31
143 RCL 31
144 10
145 —
146 7
147 /
148 XEQ "*R"
149 STO 32
150 1
151 +
152 STO 33
153 40
154 *
155 STO 34
156 RCL 32
157 30
158 *
159 STO 35
160 +
161 STO 39
162 FS? 00
163 GTO 33
164 GTO 35

165•LBL 33
166 RCL 39
167 RCL 33
168 +
169 STO 39

170•LBL 35
171 ADV
172 FIX 0
173 "FRIEND SIDE:"
174 XEQ "*D"
175 "#5FT.HOLES"
176 RCL 33
177 XEQ "*0"
178 FS? 00
179 GTO 36
180 "TNT,LBS"
181 RCL 34
182 XEQ "*0"
183 GTO 37

184•LBL 36
185 "#CRATER CHG"
186 RCL 33
187 XEQ "*0"
188 "PRIMER:TNT,LBS"
189 RCL 33
190 XEQ "*0"

191•LBL 37
192 ADV
193 "ENEMY SIDE:"
194 XEQ "*D"
195 "#4FT.HOLES"
196 RCL 32
197 XEQ "*0"
198 "TNT,LBS"
199 RCL 35
200 XEQ "*0"
201•LBL 79
202 ADV
203 "EXPLO,ΣLB"
204 RCL 39
205 XEQ "*0"
206 "ALSO: NEED SHAP"
207 "⊢E CHARGES"
208 XEQ "*D"
209 "TO BLAST BOREHO"
210 "⊢LES!"

211 XEQ "*D"
212 CF 00
213 XEQ "*P"
214 STOP
215 GTO 01

216•LBL 81
217 RCL 31
218 16
219 —

220 5
221 /
222 1
223 +
224 XEQ "*R"
225 STO 32
226 RTN
227 "2/2/82"
228 END
```

Applications Include:

CPM, Bridge Classification, Road Cratering, Demolitions, Minefield Logistics, Obstacles.

field.

Early in its study, CERL researchers worked at developing a set of subroutines to be used by one or more programs. CPT Scott Loomer, an engineer officer at the Defense Mapping School, became aware of the CERL effort and offered to contribute to the work. Working part-time, he developed standard routines that were sound and comprehensive enough to be adopted across the board. He also solved for planners another problem.

Originally, CERL's goal was to make all the calculator's programs fully self-contained so field users would not have to consult reference books to run them. Hampered by this constraint, CERL was unable to find an efficient way to approach the bridge classification problem.

Loomer invented the idea of letting the program tell the user when to use FM 5-34 to extract data from the manual's complex tables or figures. That is, the program would tell the user what table or figure to go to and what entry conditions to use.

The user now extracts and enters the data when prompted by the program. As a result of this innovation, an enormous amount of program memory was saved and the impossible became possible. One soldier's standard subroutines and referencing technique increased the effective capacity of the Engineer Programmable Calculator by about 20 percent. It also let CERL fit two more programs onto the MILENG1/UTIL module.

Here was an example demonstrating the synergistic effect that interaction with the field can create.

Program Conventions

Utility Routines

Six application programs and a set of utility routines are stored on MILENG1/UTIL. Utility routines could be used very effectively by field troops to handle a host of housekeeping chores when writing programs to meet particular needs.

Programs resident on the ROM also use these utility routines. Each program first checks to insure that enough data registers are provided. If not, the program tells the user to RESIZE. A single tone sounds whenever the program requires input. (Differently pitched tones can be used for different program applications.)

A double tone sounds whenever the program outputs information. When a program asks a yes or no question, it will accept only a "Y" or "N" response. Any other response will result in the question being repeated.

When a program asks for a numeric input, the user presses the appropriate number keys, then presses the RUN/STOP (R/S) key to input the data. The program automatically checks that the input is within acceptable range. If not, it tells the user what upper or lower limit must be met and asks for the input again.

The R/S key also is used to input the "Y" or "N" responses and to restart the program after the program outputs information. However, if a printer is attached, the program automatically continues after each output. The format between the "with printer" and "without printer" output differs only in the case of the Critical Path Method (CPM) program.

The Critical Path Method

The CPM program is an efficient way to do the tedious calculations associated with using CPM project control, a management method becoming common in today's Army. The CPM program uses "activity-on-the-node" logic.

Up to 98 activities can be analyzed if the full HP-41cv resident capacity for data storage is used; up to 20 activities can be done on the HP-41c model without memory modules. The "with printer" version prints the output in boxes. The user can cut these out, paste them up and graph logical relationships.

Figure 1 is an example of a simple network. It shows how to input data and how the output looks after it is cut, pasted and connected. Critical activities have asterisks printed in the box. This is a handy tool for those who do not have access to a minicomputer.

The "without printer" output must be copied as it is output. Then diagrams can be drawn and annotated with the correct information. Note that in the printed version, the preceding activities for each activity are noted to the left of each diagram, so the user will know how to connect the activities together.

Bridge Classification

The bridge classification program is used with certain tables in FM 5-34 to help the user determine bridge superstructure classification. This program may be used for both timber and steel stringer bridges.

The computer asks the user for the bridge's basic dimensions, etc. It then refers the user to appropriate tables and figures in FM 5-34, telling the user what entry values he needs. It asks the user for the value of the variables corresponding to those entry conditions. The user extracts the appropriate value from the manual's table or figure and enters it in the calculator.

Road Cratering

The road crater program computes the amount of explosives, number of cratering charges, and number and depth of holes needed to produce hasty, deliberate or relieved face road craters. Figure 3 shows a sample computation where the program even determines that two pounds of TNT must be used to double prime charges for each five-foot hole.

Demolitions

The demolitions program addresses three common engineer activities: cutting timber, cutting steel and breaching walls. The program lists three timber cutting options: internal charge placement, external placement and abatis.

The steel cutting option lists four application areas: railroad rails,

Printout Examples

Road Cratering

```
          XEQ "CRATER"
CRATER LENGTH, (FT)=?
          41.0     RUN
USE CRATER CHARGE (Y/N)?
Y                  RUN
CRATER TYPE:
HASTY (Y/N)?
N                  RUN
DELIBERATE (Y/N)?
N                  RUN
RELIEVED FACE (Y/N)?
Y                  RUN

FRIEND SIDE:
#5FT.HOLES=6.
#CRATER CHG=6.
PRIMER:TNT, LBS=6.

ENEMY SIDE:
#4FT.HOLES=5.
TNT,LBS=150.

EXPLO,LB=396.
ALSO: NEED SHAPE CHARGES
TO BLAST BOREHOLES!
END PROGRAM
```

Demolitions

```
          XEQ "DEMO"
EXPLOSIVE TYPE:
TNT (Y/N)?
N                  RUN
M112 C4(1.25LB)(Y/N)?
Y                  RUN
APPLICATION:
CUT TIMBER (Y/N)?
Y                  RUN
TIMBER DIA.(IN)=?
          24.0     RUN
CHARGE PLACEMENT
ABATIS (Y/N)?
N                  RUN
EXTREN (Y/N)?
Y                  RUN
REQD.      EXPLO.
LBS.=11.3
#EXPLO. UNITS=9
IN OPEN, SAFE DIST.,
M=300
END PROGRAM
```

Minefields

```
          XEQ "MINES"
ENTER MINE DENSITY:
#AT/M=?
          3.00     RUN
#APF/M=?
          4.00     RUN
#APB/M=?
          8.00     RUN
IOE CLUSTER COMPOSITION:
#AT=?
          1.       RUN
#APF=?
          2.       RUN
#APB=?
          2.       RUN
DO AT NIGHT(Y/N)?
N                  RUN
FIELD LENGTH,(M)=?
          400.     RUN
FIELD DEPTH,(M)=?
          400.     RUN

TOTAL MINES:
#AT=1,370.
#APF=1,859.
#APB=3,619.
IOE MINES:
#AT=45.
#APF=90.
#APB=90.
MMF MINES:
#AT=1,200.
#APF=1,600.
#APB=3,200.
#IOE CLUSTERS=45.
#STRIPS=9.
2-STRAND,4-SIDE FENCE:
#WIRE(RL)=13.
#SIGNS,PICKETS=165.
#SANDBAGS=3,780.
MANHOURS=962.
END PROGRAM
```

Figure 3.

round steel sections, structural steel sections and carbon steel rods. The breaching applications are used in conjunction with applicable tables in FM 5-34.

Minefield Logistics

The minefield program computes the logistical requirements for installing a standard pattern minefield given the field density, the irregular outer edge cluster composition, the field length and depth, and the conditions under which the work is to be done. A sample printout is shown in Figure 3.

Wire Obstacles

The wire obstacle program computes the logistical requirements for installing any of seven common wire obstacles. The program can also be used to compute the effective length of the obstacle according to its function and location on the battlefield.

If the user already knows the effective length, he would answer "Y" to the first question ("KNOW. EFF.LEN.(Y/N)?") and enter the effective length when asked.

Looking Ahead

By October 1982, 250 copies of MILENG1/UTIL will be produced for testing and evaluation by Engineer Officer Basic Course and NCOES students.

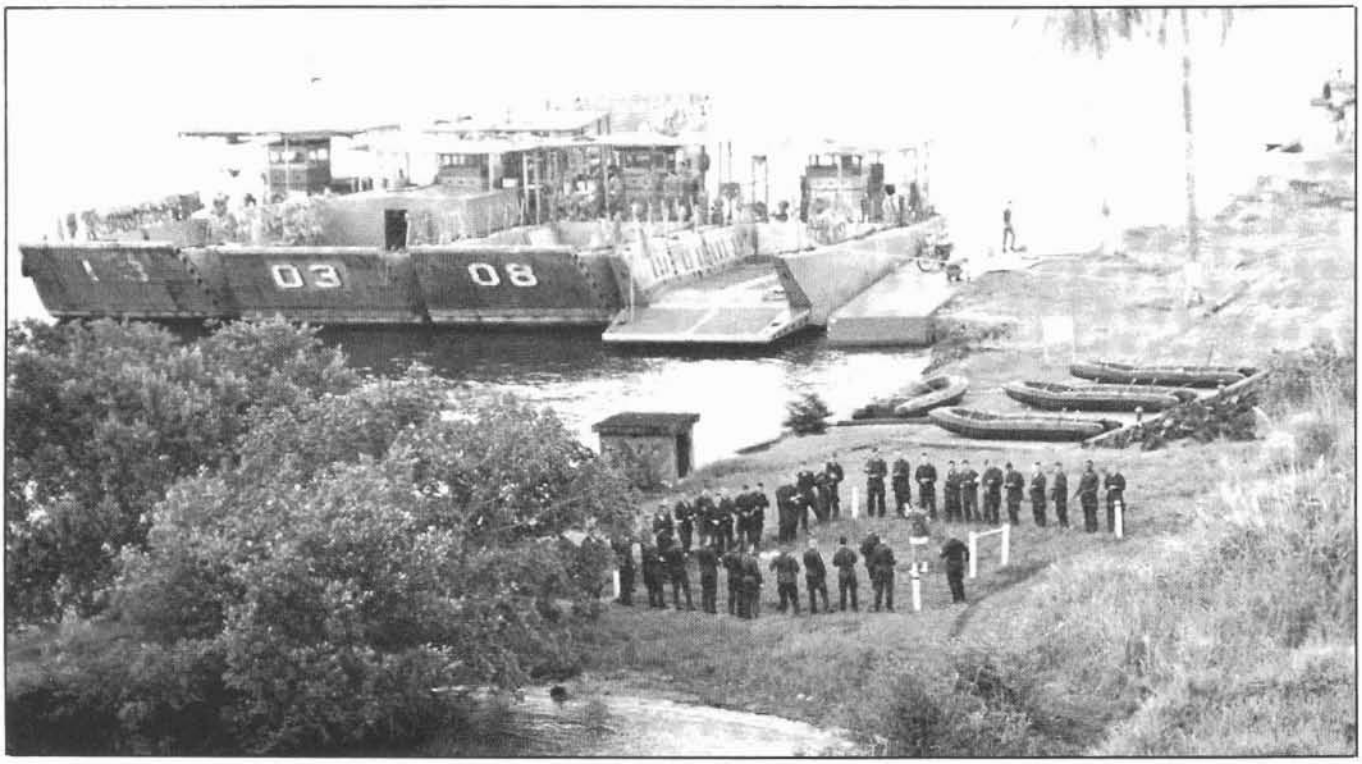
About 150 of these ROMs already are committed to the U.S. Army Engineer School, and to certain engineer battalions that will field test them. The other 100 ROMs will be made available to individual combat engineers who own or have access to an HP-41 calculator.

Written requests for these can be addressed to: CERL-FS, ATTN: John Deponai, P.O. Box 4005, Champaign, Ill., 61820. Include your full name, rank, social security number, current job description and whether or not you have access to an HP-41.

For information, contact Mrs. Gale Smith, the Engineer School's Collective Training and Analysis Division, at (703) 664-4063/3467, AVN 354.

Mr. John M. Deponai leads the Military Engineering Team at the U.S. Army's Construction Engineering Research Laboratory, Champaign, Ill. He is a 1966 graduate of the U.S. Military Academy and served for eight and one-half years on active duty.

ENGINEER SUPPORT TO RANGER OPERATIONS



Rain-soaked 92d Engineers and 1/75th Rangers practice knot tying in Panama. (Photos by John G. Martin)

by 1LT Robert B. Underwood III

The 92d Engineers excel at a unique, demanding mission.

The 1st Battalion (Ranger), 75th Infantry, is an elite unit designed to perform special infantry missions on short notice, anywhere in the world. This mission requires the Rangers to work and to train in many diverse climates and types of terrain. Despite their prodigious capabilities as infantrymen, the Rangers need engineer construction support to prepare for their missions. To meet this need, the 92d Engineer Battalion (Combat) (Heavy) keeps a Ranger Support Element (RSE) ready to be attached to the 1/75th for training exercises or for actual deployment.

The 92d, commanded by LTC Francis R. Skidmore,* is stationed at Fort Stewart, Ga., and is heavily committed to supporting the installation with construction projects. The RSE obligation provides diversity for the unit, and has enabled members of the 92d to train in Panama; at Fort Bliss, Texas; and in Puerto Rico.

The mutual respect that has developed between the 92d and the 1/75th has given engineer soldiers and appreciation for the Rangers' impressive capabilities, and has given the Rangers a keen awareness of the skill and motivation of Army Engineers. The hardest part of any support arrangement is precisely communicating what services the customer needs versus what services the supporter can provide. The RSE program has enlightened both the 92d and the 1/75th concerning the special needs of the Rangers and engineer support capabilities.

RSE Organization

Task organization for the RSE depends on the scope of the Rangers' deployment and mission. For a typical Ranger company-sized fly-away deployment, the RSE would consist of a lieutenant officer-in-charge (OIC), an E6/E7 noncommissioned officer-in-charge (NCOIC) and eight enlisted men. A battalion-sized Ranger deployment would require an RSE OIC, NCOIC and 19 enlisted personnel. RSE is rotated between line companies on a quarterly basis. Within the tasked company, responsibility for the RSE is split between the two general construction platoons.

Equipment taken by any size RSE includes a 5/4-ton M880 cargo truck loaded with a generator, power and hand tools, pioneer tools, chain saws, a demolition kit and repair parts. This gives the unit the ability to handle a wide variety of construction and combat engineer missions. Heavy equipment operators, communication specialists and medics may augment the RSE depending on mission requirements.

The M880 is stored ready for air movement, having been technically inspected by the battalion's material readiness office and all faults corrected. The vehicle is marked for weight and center of gravity; hazardous cargo forms and vehicle loading plan are also completed. The truck is stored loaded and with special instructions for the RSE. In the event of an alert, it needs only to be dispatched and driven to the airfield.

Readiness is always a primary requirement for the company tasked for RSE. When the 1/75th is in a "ready" posture, the RSE platoon members remain at all times where they can be contacted by telephone, and company duty personnel are issued an RSE alert roster with special notification instructions. All RSE personnel are administratively and medically cleared for overseas deployment.

RSE Missions

If alerted, the RSE deploys with the Ranger advanced party to construct and to maintain a Ranger element mobilization base (REMAB), build rehearsal sites, and as time permits, to train.

REMAB construction varies but usually includes organizing and laying out the base, supervising tent erection, constructing latrine facilities, setting up power distribution and lighting, erecting protective fences and establishing a shower point using M12A1 decontamination apparatus.

Rehearsal sites are as unique as the Ranger mission. Camps, buildings, bunkers and their attendant obstacles are often built. These facilities are constructed to resemble as closely as possible actual objective sites and are based on information provided by the Ranger intelligence section. The accuracy of rehearsal sites is critically important to the success of the Ranger operation.

Sometimes, schedules permit the RSE to participate in environmental training with the Rangers. This provides adventure-training opportunities for engineer troops not familiar with advanced infantry skills and working in difficult terrain and climates. Such training naturally supports the engineer secondary mission of fighting as infantry.

RSE Deployments

The 92d Engineers' RSE training deployments have provided a wealth of challenges and exciting training. The major environmental training deployments have been to Panama in December 1981, Fort Bliss/White Sands Missile Range in February 1982 and to Puerto Rico in June 1982.

During the deployment to the Jungle Operations Training Center (JOTC) at Fort Sherman, Republic of Panama, the Rangers received refresher training in individual skills peculiar to a jungle environment. They also trained in platoon and company-sized operations, and held a battalion field training exercise (FTX). The 10-man RSE was integrated as a squad into a Ranger platoon for individual, squad and platoon-level training. All RSE members were awarded the JOTC Jungle Expert Certificate. In many activities, such as the land navigation and nine-event obstacle course, the engineer squad scored comparably to the highly-competitive Ranger squads. The winter being the wet season in Panama, it

92d Engineers lash equipment in a RB15 assault boat while preparing for training on Panama's Chagres River.

"When they saw what we could do, the Rangers went wild."

rained every day during the deployment.

At their request, the RSE during off-duty time received additional JOTC training in helicopter rappelling and in lowering pioneer boxes from a helicopter. The extra training culminated with the RSE rappelling into the jungle and clearing a landing zone using explosives.

These activities were certainly a change of pace for the dozer operators, carpenters, plumbers and draftsmen from the 92d. Besides the JOTC training, the RSE served as the planning and control party to establish a REMAB for the Ranger FTX; objectives and rehearsal sites were built beforehand by the 518th Engineer Company from Fort Kobe, Panama.

Construction Challenge

During the Fort Bliss deployment, the Rangers found out how hard engineers could work and how much could be built in a very limited amount of time.

Although the RSE leader knew some construction tasks were planned, according to RSE OIC 1LT William R. Weeks, the size of the construction mission mushroomed once the RSE deployed. "When they saw what we could do, the Rangers went wild," Weeks said. "They kept asking for more, so we kept giving them more."

During the three-week exercise, the 20-man RSE constructed six mock enemy camps complete with buildings, towers, sandbag positions and protective wire. The RSE used 1,100 $2 \times 4 \times 10$s, 600 sheets of plywood and 600 pounds of nails.

They also built numerous targets and vehicle silhouettes for live-fire ranges, as well as a protective bunker from which a brave young Ranger (who had been late for formation) could safely operate downrange targets. A MOUT (military operations in urban terrain) site was erected and another rehabilitated. Barracks and offices used by the 1/75th were also rehabilitated.

The construction tasks were made difficult by winds gusting to 50 knots and a prohibition on digging because of the danger of disturbing Indian artifacts. Some structures were secured with wooden footings, but each case of digging required specific, prior approval from the host installation. Several buildings without footings blew down under the severe winds, and the RSE had to rush to repair them before the Ranger assaults began.

RSE members later reported that watching the Rangers in action was one of the exercise's highlights. The group saw several impressive Ranger assaults targeted against engineer construction projects. The attacks were live-fire exercises complete with air strikes and rolling mortar barrages.

Engineers Praised

According to John G. Martin of the Fort Stewart Public Affairs Office, the 92d Engineers were also very impressive. An Army veteran who served in Vietnam with the 5th Special Forces Group, Martin was with the 1/75th during all three RSE deployments. "The engineers did an outstanding job in Panama and Puerto Rico, and they *really* performed well at Fort Bliss," Martin said. "I never heard any complaining; they just kept putting out at a hundred percent and then some. It amazed me how much spirit they had. They showed themselves to be true soldiers."

The Fort Bliss exercise was particularly intense. The RSE worked around-the-clock in 18-hour shifts;

Incessant rain and the rigorous JOTC obstacle course didn't slow the engineer RSE in Panama.

sometimes shifts lasted 24 hours. Exemplifying the 92d Engineers spirit was SSG Johnny Edwards. Serving as the B Company motor sergeant, Edwards was named RSE NCOIC when it appeared that the exercise would duplicate the Panama experience: mostly adventure training and only a few construction tasks. Once the RSE got to Fort Bliss and the construction mission dramatically increased, Edwards found himself on unfamiliar ground as a construction supervisor. His dedication, however, overcame the handicap and he played a key role in successfully managing the construction mission.

During the Fort Bliss deployment, the RSE also trained in mountaineering and patrolling, participated in an airmobile operation, and served as aggressors.

The RSE that accompanied the 1/75th to Puerto Rico encountered a more even mix of training and construction requirements. Rehearsal and objective sites were constructed or rehabilitated, wire erected and obstacles built. Engineers participated in adventure and infantry training similar to what was encountered during the previous deployments.

Valuable Training

The experience and lessons learned by members of the 92d Engineer Battalion during these environmental deployments have been valuable and numerous. The rapid deployment requirement for the RSE keeps the battalion staff and companies sharp on deployment criteria and procedures. The deployments have provided challenging leadership experiences for officers, NCOs and troops. Trips to faraway places have been a definite morale booster for the soldiers fortunate enough to participate.

The program also has provided strong motivation for troops to raise their personal standards since men are chosen for the RSE based on demonstrated daily duty performance. The finer points of living and staying healthy in the field learned from the Rangers have been passed along to buddies and are reflected in better unit performance during field problems.

Most importantly, the 92d Engineers have learned how important and rewarding it is to aggressively support an outstanding infantry unit like the 1/75th Rangers.

*LTC James Keys commanded the 92d during these RSE deployments.

1LT Robert Underwood is an Engineer Officer Advanced Course student at Ft. Belvoir, Va. He served with the 92d Engineer Bn., Ft. Stewart, Ga., as a platoon leader, pipeline engineer and construction officer. 1LT Underwood was RSE OIC on the Panama deployment. He is a graduate of the U.S. Military Academy, Airborne and Ranger Schools.

Engineer Equipment Display

The Engineer Center's Directorate of Combat Developments participated this summer in a "Week of the Eagles" open house and display at Fort Campbell, Ky. The event was sponsored by the 101st Airborne Division (Air Assault).

During the five-day event, thousands of soldiers and civilians saw how divisional engineers might support the combined arms team in the Airland Battle. An Engineer Center survivability display featured several developmental fighting position covers; equipment shown included the M9 Armored Combat Earthmover (ACE), a M180 cratering charge and the Ground Emplaced Mine Scattering System (GEMSS).

Also displayed in the engineer corner was a Marine Corps Mine Clearing Line Charge (MICLIC, M58A1) and a UNIMOG, the West German small emplacement excavator currently being tested at Fort Lewis, Wash.

The engineer display at Ft. Campbell's "Week of the Eagles" included these prototype fighting position covers. (Photo by CPT James E. Burrows)

Paint Problems

by Alfred Beitelman

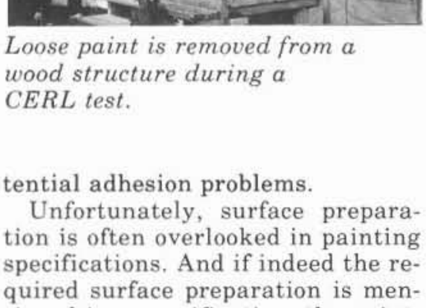
The Paint Laboratory at the U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, Ill., is responsible for evaluating difficulties in the field application of paints. Over the past several years, lab personnel have visited many field painting operations and have observed specific, recurring problems which reduce coating life and eventually shorten the life expectancy of the painted item.

Many problems that at first glance appear to involve poor paint performance actually reflect a disregard of good painting principles—a disregard evident from basic design to inspection of the painted item. Coatings are the first line of defense against corrosion, but they can only provide their designed protection if they are properly specified, applied and maintained.

When an item needs a paint system for protection or beautification, the coating should be considered in the initial design stages and not left as an afterthought. The size of the item is of little consequence. It may be small enough to hold in the palm of your hand or large enough to span a major river. The basic principles are the same in both cases. The surfaces should be simply configured and must be accessible to allow appropriate surface preparation and coating. In addition, there should be no deep crevices, unnecessary protrusions or sharp corners. Such irregularities are difficult to coat uniformly and are particularly susceptible to physical damage. A surface such as the smooth exterior of an automobile is ideal for painting.

The designer must also be aware of the need to protect concealed surfaces. Inaccessible compartments and complex structural members are major obstacles when coatings are applied.

Proper paint performance depends heavily on adequate surface preparation. It should be obvious that paint will not adhere to a wet or oily surface. Most paints are not designed to adhere to heavy deposits of dirt or chalk. Repainting hard, tile-like surfaces or aged, high-gloss paints also presents potential adhesion problems.



Loose paint is removed from a wood structure during a CERL test.

Unfortunately, surface preparation is often overlooked in painting specifications. And if indeed the required surface preparation is mentioned in a specification, the painting contractor will often minimize the time spent on this operation.

Some contractors tend to believe that a quick coat of paint will cover most defects. Problems resulting from this attitude can be prevented by close inspection and clearly written specifications which include tasks such as weld spatter removal, solvent cleaning, glass removal, removal of corrosion products or poorly adherent coatings, and the treatment of mildew.

Quality is often compromised in the interest of speed, not only during surface preparation, but also in paint application. Sometimes a complete coat is omitted from an item; on many painting jobs, given areas receive fewer coats than specified. To reduce costs for materials, some applicators thin the paint too much. Again, detailed inspection could control most of these mistakes.

Effective paint inspection programs are usually not considered (much less implemented) when painting operations are underway. If an inspector is present, he often is not given the appropriate thickness gauges, pinhole detectors or other inspection equipment. He is sometimes responsible for all inspection duties on several jobs being done simultaneously. To be truly effective, he would have to be intimately familiar with all construction items used in the projects—from the concrete in the footings to the asphalt on the roof—and he would have to be at each project site all the time. Obviously this is impossible.

If a coating is to be truly effective, it must be more than an afterthought in the design process. Painters must think in terms of "high-performance protective coatings" rather than "cover it up with a coat of paint," and inspection must be given high priority to insure a quality product.

Alfred Beitelman, a chemist in the Paint Laboratory, U.S. Army Construction Engineering Research Laboratory, Champaign, Ill., is a principal investigator for civil works and military construction paint research programs. He holds a B.A. in chemistry from Wartburg College, Waverly, Iowa., and has been with the Paint Laboratory for 11 years.

The ENGINEER Solution

1. Assumptions

- Simply supported continuous beam
- Compact section
- Adequate lateral bracing

2. Member Selection

• Using page 2-126 of the 8th Edition, AISC Manual of Steel Construction, calculate the maximum moment and shear due to loading:

$$\begin{aligned} M_{max} &= 0.10\ wl^2 & V_{max} &= 0.600wl \\ &= 0.10(1.5kfp)\ (30\ ft)^2 & &= 0.60(1.5kfp)\ (30\ ft) \\ \underline{\underline{M_{max}}} &\underline{\underline{= 135.0\ ft\text{-}kips}} & \underline{\underline{V_{max}}} &\underline{\underline{= 27\ kips}} \end{aligned}$$

• From page 2-8 of the AISC Manual, select $\underline{\underline{W\ 18 \times 40}}$ with moment capacity of 137.0 ft-kips.

• Additionally, from page 1-8, find the following properties:

$$\begin{aligned} tw &= 0.315\ w \\ d &= 17.90\ in \\ I &= 612\ in^4 \end{aligned}$$

• Check shear from page 5-65 of the AISC Manual:

$$\begin{aligned} Vu &\leq 0.55\ fy\ td \\ \text{where, } Vu = V_{max} &\leq (0.55)\ (36\ ksi)\ (0.315\ in)\ (17.90\ in) \\ 27\ k &\leq 111.64\ k \end{aligned}$$

• Shear okay. Use W 18 × 40.

3. Maximum Deflection

• Using the expression from page 2-126 of the AISC Manual, find:

$$\Delta max = 0.0069wl^4/EI$$

• Thus,

$$\Delta max = 0.0069(1.5\ \frac{kip}{ft} \times \frac{1\ ft}{12\ in})\ (30\ ft \times 12\frac{in}{ft})^4/(29{,}000\ ksi \times 612\ in^4)$$

$$= 0.0069\ (0.125\ \frac{kip}{in.})\ (360\ in)^4/(1.7788 \times 10^7\ kip\text{-}in^2)$$

$$\boxed{\bullet\ \Delta max = 0.816\ in}$$

Combat engineers from Ft. Belvoir's 902d Engineer Co. (Assault Float Bridge) (Ribbon) cross Tompkins Basin under simulated enemy fire. (Photo by SP4 Val Witter)