AIR UNIVERSITY

# REVIEW


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EXERCISE DESERT STRIKE: CONCEPT AND OPERATIONS . . .
INCENTIVE CONTRACTING . . . COMPUTER SCIENCES RESEARCH

NOVEMBER-DECEMBER 1964

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the cover

The vastness of the Mojave Desert became a real and sometimes ominous presence to the more than 100,000 ground troops and airmen foregathered there in May this year to participate in Exercise Desert Strike. *Air University Review* presents a word and picture report on this largest of all U.S. Strike Command exercises.

# EXERCISE DESERT STRIKE
## Concept and Operations

An Air University Review Staff Report*

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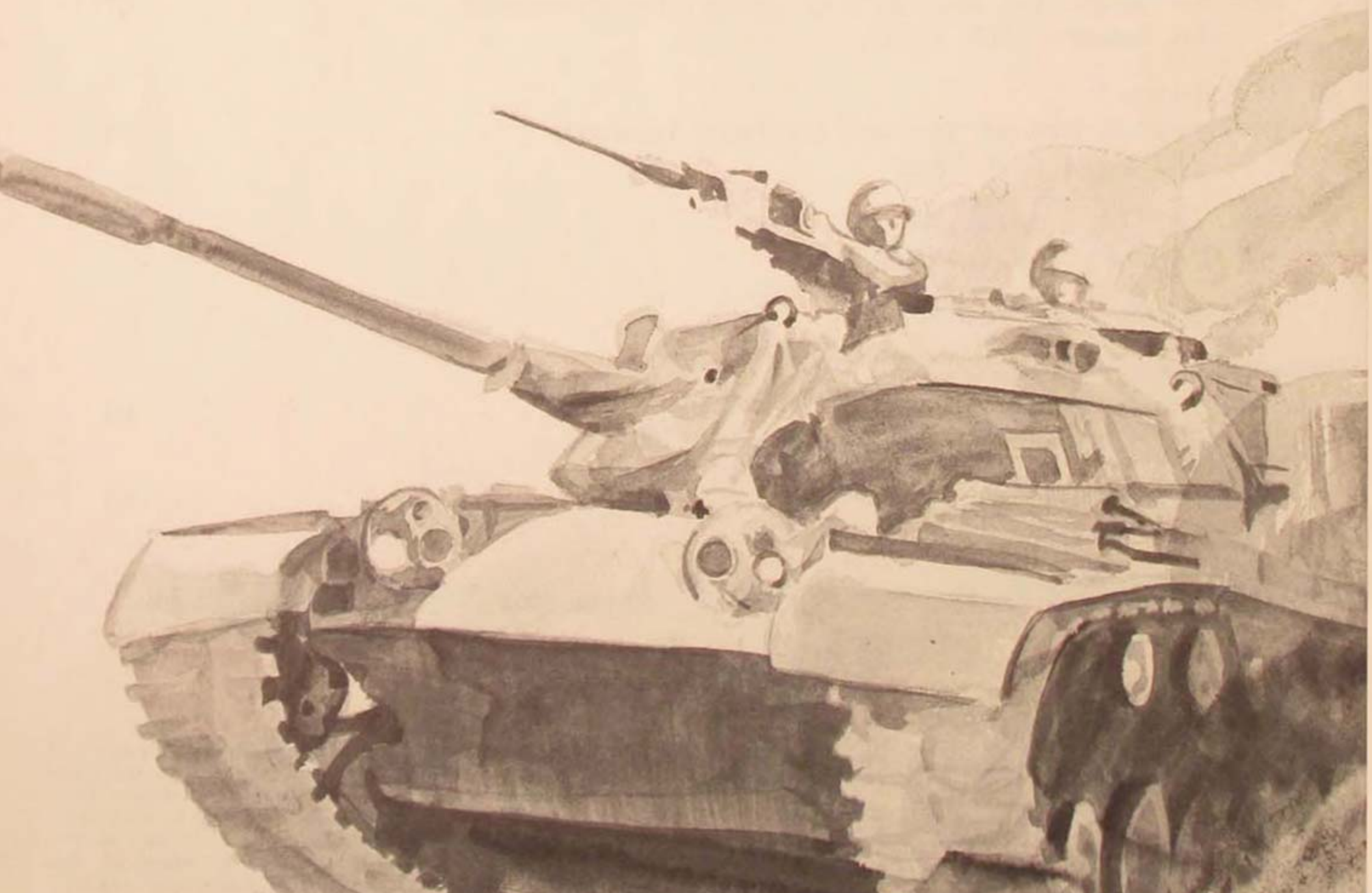


THE LARGEST United States military training exercise since World War II was conducted in May 1964 by the U.S. Strike Command in adjoining areas of California, Arizona, and Nevada. It was also the first armored exercise held in the United States since World War II. Two joint task forces with a total of over 100,000 personnel of the U.S. Air Force and Army, over 900 aircraft, and more than 500 tanks battled for nearly two weeks on a ground maneuver area of some 13 million acres in the desert region of southwestern United States. As in past joint exercises, tactical nuclear weapons training was conducted during the play of the exercise.

Appropriately called Desert Strike, the air maneuver area covered three quarters of a million square miles, with aircraft operating from 28 widely dispersed air bases extending from the State of Washington through Texas. Incidentally this desert was also the setting for the last training exercises for armored units of such mammoth proportions—in 1942–43—when it became known as "General Patton's Training Center" during extensive ground maneuvers there. The Desert Strike ground maneuver area extended from Barstow, California, just

*The Editor wishes to acknowledge his indebtedness to Lieutenant Colonel Edward B. Vogel, USA, Directorate of Operations (J-3), Hq USSTRICOM, who assisted in the preparation of the report.

east of Edwards Air Force Base, eastward 170 miles to Kingman, Arizona, and from a point approximately 40 miles south of Las Vegas, Nevada, southward 160 miles to Blythe, California. This area, consisting primarily of portions of the Mojave Desert and the irrigated lands along the Colorado River, was typical of desert terrain, with extreme differences in elevation, varying from large flat expanses of sandy desert floor to jagged, rough mountain ranges.

Desert Strike was a semicontrolled exercise under the direction of U.S. Strike Command that allowed opposing joint task forces, comprised primarily of armored and mechanized forces with full air support but including airborne units, a maximum of "free play" initiative to develop, perfect, and test combat techniques and tactics. Command control was exercised only when necessary to ensure meeting objectives of the maneuver. "Training in modern warfare for our combat-ready Army and Air Force units requires the use of land areas many times larger than areas of even the largest military reservations," said General Paul D. Adams, Commander in Chief, USSTRICOM, and Exercise Director. The maneuver area was selected primarily because the desert terrain is suitable for large-scale tank movement and because of its relatively sparse population. The dispersal of Air Force units over distances similar to those expected in actual combat, together with the freedom of action which was given the JTF commanders in their employment of ground and air units, ensured a realistic no-set-pattern course of combat maneuvers typical of USSTRICOM exercises. Emphasis was placed on allowing Air Force commanders the maximum amount of flexibility in selecting bases for their fighter, reconnaissance, and troop-carrier squadrons. The initial planning objective was to obtain 1½ air bases per fighter squadron involved in the exercise, which would allow the Air Force commander the flexibility of moving squadrons from one base to another or dispersing squadrons or parts of a squadron among different bases. This flexibility also permitted the Air Force commander to use close-in air bases, near the ground maneuver area, as forward operating bases. As a result of this emphasis and guidance, the air bases acquired for exercise play included not only Tactical Air Command bases but other Air Force bases, Navy and Marine air bases, and civilian airfields.

Lieutenant General Charles G. Dodge, Commanding General, Fifth U.S. Army, commanded Joint Task Force Phoenix. His deputy was Air Force Major General Clyde Box, Director of Plans, USSTRICOM. JTF Phoenix defended the mythical country of Nezona, generally east of the Colorado River, beginning at a point southeast of Salome, Arizona, extending north of Kingman, Arizona, through the southern tip of Nevada, and back to the Colorado River.

Lieutenant General Charles B. Westover, Vice Commander, Tactical Air Command, commanded the opposing Joint Task Force Mojave of the mythical country of Calonia. His deputy was Army Major General Charles H. Chase, Special Assistant to the Commander in Chief, USSTRICOM. JTF Mojave conducted land operations in the Mojave Desert area west of the Colorado River, the northern boundary running from the river west to Fort Irwin, California, southeast to Blythe, California, then back to the river.

Major General John C. Meyer, Commander, Twelfth Air Force (TAC), at Waco, Texas, was designated as Chief Controller (Umpire). He formed his umpire planning group at Luke AFB, Arizona, on 24 February. This group had the mission to determine exactly how Joint Exercise Desert Strike would be umpired, the command and control procedures to be used in umpiring the exercise, and to prepare and publish an umpire handbook.

The Director Headquarters and Headquarters Neutral Forces were established at Needles, California. This location permitted both these headquarters to be centrally located within the ground maneuver area and was adjacent to a town with adequate accommodations for the observers expected during the exercise.

All commanders were briefed by General Adams and his staff over a two-day period on the background and purpose of Exercise Desert Strike, the command and control to be used in the exercise, and all the necessary background material to permit them to form their staffs and develop their initial plans.

The General Plan for Desert Strike, published on 25 March, was a directive providing necessary information for deploying forces to the exercise area and outlining the rules of the exercise and plans for redeployment of forces. This was not a tactical operations plan. It was very general in providing commanders and supporting forces with a background political/military situation to set the stage for the exercise but included no tactical information. Each commander also received his operational missions from the Exercise Director. These were contained in separate contingency-type plans presented to each commander, which provided him with specific military and political information and details, including his task organization, overall tactical mission, and the concept of operations.

The command structure of Exercise Desert Strike consisted of three principal forces: Joint Task Force Mojave, Joint Task Force Phoenix, and the Director Reserve. JTF Mojave initially consisted of the following units:

Headquarters, XVIII Airborne Corps

- 1st Armored Division
- 5th Logistical Command

Headquarters, Ninth Air Force

- 4 fighter squadrons
- 1 composite reconnaissance squadron
- 1 troop-carrier squadron (C-130)
- 18 Air Defense Command aircraft
- 10 refueling aircraft (Strategic Air Command).

JTF Phoenix consisted of the following units:

Headquarters, III Corps

- 2d Armored Division
- 5th Infantry Division (Mechanized)
- 258th Infantry Brigade (Arizona) (Army National Guard)
- 191st Infantry Brigade (Arizona, Montana, Utah) (Army Reserve)
- 1st Logistical Command

Headquarters, Twelfth Air Force

- 6 fighter squadrons
- 1 composite reconnaissance squadron
- 1 troop-carrier squadron (C-130)
- 18 Air Defense Command aircraft
- 10 refueling aircraft (Strategic Air Command).

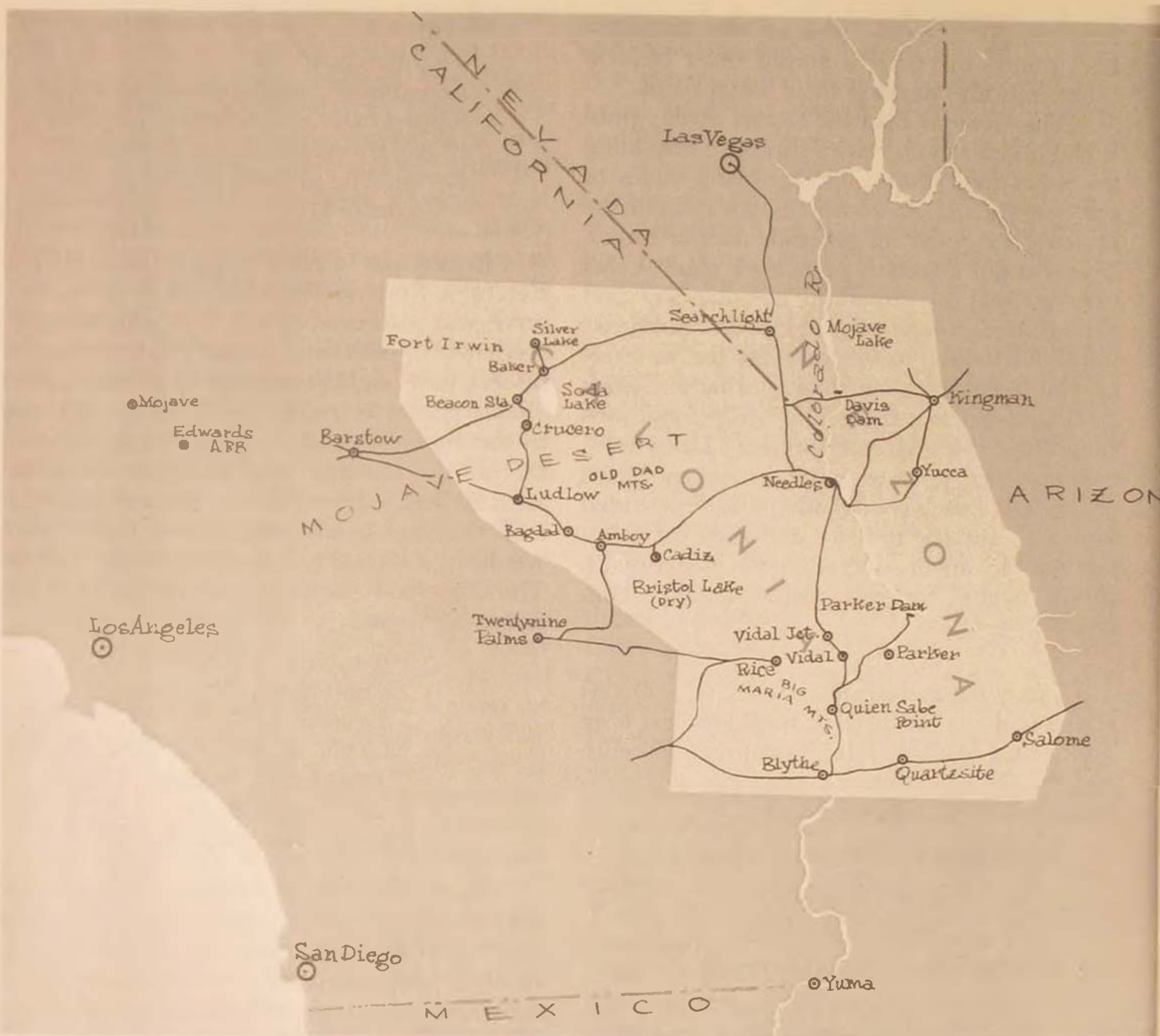
In addition to the two opposing Joint Task Forces, a third force called the Director Reserve was also established. This Director Reserve was to simulate a strategic or a theater reserve that might be moved from continental United States or from strategic staging bases to the forward combat area. It was planned that all the Director Reserve forces would be initially located within the Mojave territory and that on a scheduled basis these units would be attached to Joint Task Force Mojave. The Director Reserve initially consisted of the following units:

- 101st Airborne Division
- 2d Battalion, 34th Armored Division
- 2d Brigade, 40th Armored Division (California National Guard)
- 6 fighter squadrons
- 6 troop-carrier squadrons.

For the first time in a large-scale USSTRICOM joint exercise, major reserve component Army and Air Force units were involved. Air Force reserve component units included three provisional fighter squadrons and major elements of the 152d and 157th Aircraft Control and Warning Wings. Army reserve component units consisted of three brigade-size units and a number of combat and combat support battalions.

The 101st Airborne Division, a part of the Director Reserve, was initially deployed by the Military Air Transport Service to intermediate staging bases at Mojave-Kern Airfield, California, a civilian airfield approximately 20 miles west of Edwards AFB, California, and to Point Mugu and El Toro Naval Air Stations, California.

By 20 April the initial elements of the player units moved into the ground maneuver area. They consisted primarily of advance par-



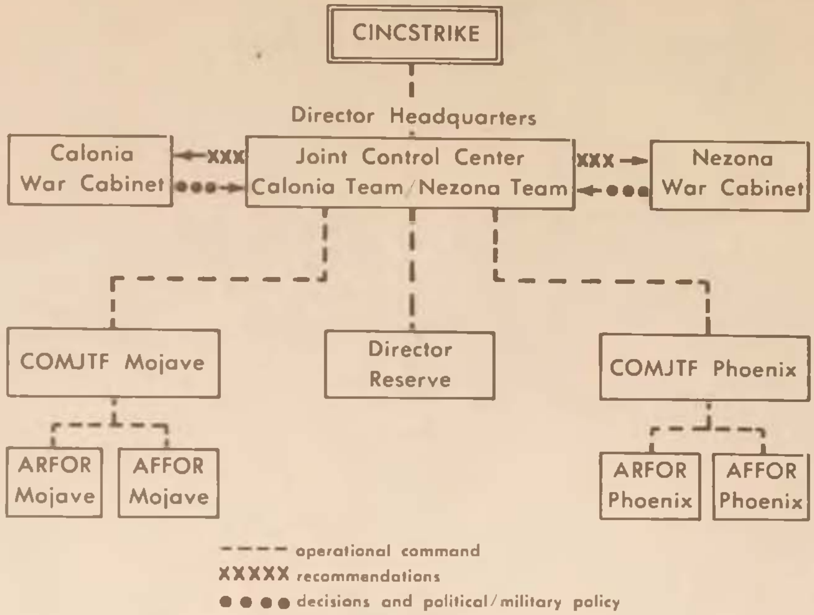

*In May of 1964, a 22,000-square-mile slash of southwestern desert (light area) was the battleground for U.S. Strike Command's Joint Exercise Desert Strike.*

ties of administrative and logistical support units required to meet loaded trains and vehicle convoys. Air Force radar installations and ground support units commenced moving to the ground maneuver area and to the air maneuver bases early in May. The Director Headquarters became operational at Needles on 9 May.

The political situation that gave the exercise realism and brought about the "war" was a dispute between the mythical countries of Nezona and Calonia over Colorado River water rights. Also Calonia's State of Mojave on the west of the Colorado River had belonged to Nezona before World War I, and Nezona felt justified in attempting to reoccupy


*General Nathan F. Twining, USAF Ret., in his role as Prime Minister of Calonia, announces a state of war between his country and Nezona.*

Mojave to ensure her control of the river. The Organization of Western States had attempted, unsuccessfully, for ten years to settle the dispute between Nezona and Calonia. The exercise began shortly after Nezona threatened to seize the Parker and Davis Dams, on the Colorado River, and the eastern part of the State of Mojave. The seriousness displayed by the planners and participants of the exercise and the efforts to make the background a realistic political-economic-military situation were indicated by the selection of personnel as participants in this phase of the play. General Nathan F. Twining, USAF Retired, former Chairman, Joint Chiefs of Staff, was the Prime Minister of the mythical country of Calonia. General Jacob L. Devers, USA Retired, former Commander, Army Field Forces, was the Prime Minister of Nezona. The war cabinet of each of these political leaders was made up of retired and former high-ranking military and political leaders. Each held war cabinet




*The War Cabinets of Calonia and Nezona were each the equivalent of a National Security Council. The Joint Control Center was the equivalent of a Joint Chiefs of Staff organization. The government of Calonia had General Nathan F. Twining, USAF Retired, as Prime Minister, and General Clyde Davis Eddleman, USA Retired, as Defense Minister. The government of Nezona had General Jacob L. Devers, USA Retired, as Prime Minister, and Lieutenant General Ira C. Eaker, USAF Retired, as Defense Minister.*

meetings twice daily to go over the war situation, issue political statements, and make suggestions.

The Joint Control Center (JCC) at Director Headquarters had integrated Mojave and Phoenix Operations and Intelligence Teams, which paralleled the responsibility of our own Joint Chiefs of Staff. Tactical situations requiring national-level decisions were presented to the appropriate War Cabinet. In turn, direction and decisions issued by the War Cabinets were implemented by the JCC organization through operations orders and frag orders to the joint task forces.

Both these countries were depicted as having a democratic form of government with a president, prime minister, foreign minister, and minister of defense. Nezona's government, however, was portrayed as being very unstable, with the Conservative Party initially in power. On 12 May the president of Nezona announced the formation of a new government composed primarily of National Progressives, the opposition party, who had been agitating to regain the State of Mojave. At 1400 hours 15 May diplomatic relations were severed between the countries of Nezona and Calonia. Late on the same afternoon the Organization of Western States indicated that it was withdrawing from the demilitarized zone. As a result, early on 16 May Joint Task Force Mojave was ordered to seize, secure, and simulate operation of the Parker and Davis Dams. The dams were seized by company-size units at 0500 of the same day. Tactical air forces were restricted from violating the boundaries with either combat or reconnaissance aircraft prior to the actual initiation of hostilities. Calonia's action in seizing the Parker and Davis Dams sparked offensive action by JTF Phoenix, the opposing military force. On 16 May Nezona declared war against Calonia and issued orders to JTF Phoenix to conduct offensive actions to seize the State of Mojave.

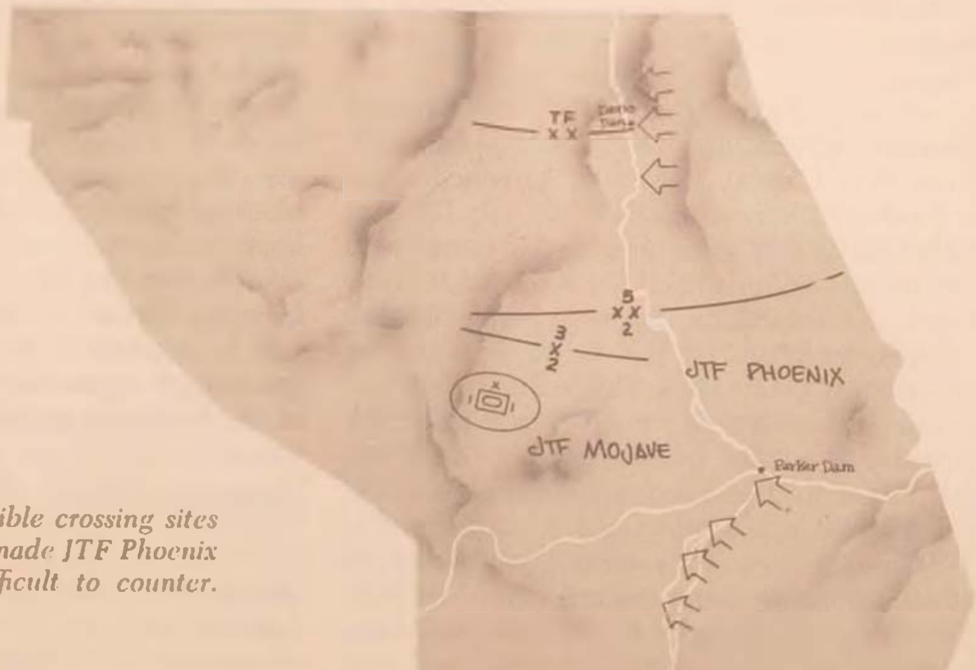
## The Desert Strike Campaign

Major activities got under way in the exercise on 18 May (D+1) as JTF Phoenix's 2d Armored Division ("Hell on Wheels") of World War II fame began to move across the Colorado River below Parker Dam. The nonnuclear attack with all brigades on line and only battalion-size reserves began in the early evening of the 17th so as to avoid visual detection by reconnaissance flights of JTF Mojave (Map 1).

### *initial offensive*

JTF Mojave, faced with two-to-one odds, deployed its units in a mobile defense, with the intention of maintaining dispersion but at the same time being prepared to mass quickly to eliminate bridgeheads. The Phoenix tactics of crossing at many points made this plan of defense difficult to implement, in that the defenders had to decide quickly which crossing to block or delay and which to counterattack. Phoenix made maximum-effort attacks with simulated nuclear weapons against Mojave airfields which were so successful that on the morning of 18 May (D+1) Mojave had no available aircraft for close air support or counterair missions. As a result, by 1700 hours on D+1 (20 hours after the initial attack) JTF Phoenix had completed three pontoon bridges and was moving the bulk of its heavy armor and support units over the river. The crossing was completed successfully through the efforts of the 17th Engineers of the 2d Armored Division from Fort Hood, Texas, in setting up a pontoon bridge. Through the first night some 964 pieces of assorted battle equipment moved in a steady stream across this structure. Only once, at 0830 the next morning, was the crossing interrupted, and then only briefly when two low-flying F-84F's of JTF Mojave attacked and the umpires on the scene declared the bridge out of action for two hours.

The pontoon bridge was a series of rubber boats supporting corrugated-steel planking anchored securely to both banks of the free-flowing river. One of the tricks in this particular crossing was to make sure that all activities occurred at a time when the gates of the massive Parker Dam to the north were closed and




*Map 1. Inaccessible crossing sites on a wide front made JTF Phoenix night attack difficult to counter.*

the level of the river was constant. The rise and fall of the Colorado, with its dams, and the swiftness of its flow could play havoc with a crossing.

As elements of the 2d Armored Division got across the bridge, they picked up speed immediately and fanned out on roads and on trails into the desert country in their determined drive westward to occupy Calonian territory. Their immediate objective was not disclosed, but as they fanned out in the desert with armored columns in the direction of Rice and Vidal Junction they encountered only sporadic slash-and-run resistance. The Mojave forces fell back in the face of the headlong frontal assault. The extreme caution observed by the forces of JTF Phoenix was indicated by one of the officers of 2d Armored Division's G-3 staff: "Probably the enemy will pick their place to stand and fight. We have to be careful to keep our lines of communication open and not get taken by surprise. We are continuing reconnaissance by both air and ground to ensure that we know where our enemy is at all times and to preclude getting encircled by the Mojave forces." Some of the elements of the 2d Division ranged as far as 35 miles west, near Rice. Their scouting parties continued to probe and push the Mojave forces in an effort to open gaps in their defenses for advances by the main body of the deploying Phoenix forces.

Strong armored and mechanized forces of Phoenix's 5th Infantry Division (Mechanized) from Fort Carson, Colorado, launched a coordinated attack across the Colorado River at Lake Mojave in a surprise move timed with the more southerly 2d Division's move westward, the immediate objective being the desert metropolis of Needles, California, and the securing of Davis Dam. Other units identified in the northern attack were the 191st and 258th Infantry Brigades. Infantrymen of the 258th, supported by their own artillery, crossed the Colorado River starting at midnight Sunday 17 May (D-day). They used assault boats to effect a crossing about ten miles north of Needles, after all bridges in the area had been knocked out. The brigade crossing took only 1 hour and 20 minutes. The deepest penetration reached on 18 May was in the vicinity of Sacramento Springs. Crossings were also reported at Parker and Quien Sabe Point. Nezonan forces moved as far west as the Big Maria Mountains. Nezonan air forces struck as far west as Mather AFB, California. Air strikes included low-level strafing attacks and conventional bombing. Working hand in hand with the Army ground forces at each river crossing, Tactical Air Command forward air controllers (FAC) arranged for fighter cover to fly over the bridgehead to ensure that no further interruption from attacking aircraft interfered with the crossings.

The operation involved the transport of tanks and armored personnel carriers across several hundred meters of water by engineer units in support of the assault. The operation was made particularly difficult by steep, deeply eroded banks and loose soil on both shores.

The 258th Infantry Brigade's participation in the assault as an element of the 5th Infantry Division (Mech) marked the first time a major combat element of the Army National Guard had taken part in a field exercise as an element of an active Army combat division.

The ground situation through D + 2 remained fairly stable in the north, with the 5th Infantry Division holding a bridgehead approximately four miles in depth. In the south, however, the 2d Armored Division had expanded its bridgehead to a depth of approximately 25 miles and was preparing for a major breakout. During the night of D + 1–D + 2, JTF Mojave moved its corps reserve into a blocking position along the main avenue of approach in the south.

During the first three days interceptors from Air Defense Command played a major role in supporting the efforts of each force in gaining air superiority, flying on the average of 2½ sorties per aircraft per day.

### *ground/air warfare*

This spacious western area was chosen for this particular maneuver so that Army heavy armored units would have room to move and demonstrate their maneuverability and driving power. Their moment of triumph came on 20


*Map 2. On D+3 Nezonan forces put a squeeze on JTF Mojave.*

May (D+3) as the 2d Armored Division scored a major breakthrough in the area northwest of Blythe by executing a turning movement, penetration, and flanking attack, causing a complete collapse of the Mojave southern defensive line (Map 2). Units of its 1st and 2d Brigades had overrun the 1st Armored Division command post, capturing the division chief of staff, 69 other personnel, and a number of vehicles.

Units of the two opposing armored divisions were intermingled, and the status of the defending forces in this area was unclear, though their danger of being overrun was evident. In the center, units of the 5th Infantry Division (Mech) and the 258th Infantry Brigade continued to make steady progress west of Needles. In the extreme northern sector Task Force Linvill, of the XVIII Airborne Corps, Fort Bragg, North Carolina, continued to defend successfully west of Searchlight against attacking battalions of the 5th Division. The task force consisted of two cavalry squadrons, an airborne infantry battalion, and an armored artillery battalion.

Exercise Desert Strike was a special challenge to the Tactical Air Command in several ways. First, it gave TAC a chance to operate in a training exercise with air bases whose distances and locations in relation to the combat areas were commensurate with those that could very well be found in an actual war. Second, it employed simulated tactical nuclear weapons under controlled conditions. And third, it provided an excellent opportunity to demonstrate clearly the flexibility of U.S. tactical air power.

The peril of the 1st Armored Division in the Cadiz Valley on 20 May provided a very good chance to demonstrate this tremendous flexibility of air power. The stage was set when the U.S. 2d Division made a surprise nighttime thrust against the JTF Mojave flank, defended by the U.S. 1st Armored Division. The 2d Division's armored column penetrated 75 miles on the flank and to the rear of the unsuspecting Calonia defenders. By dawn, when the 1st Armored Division commander discovered the situation, the threat was clear and unmistakable. The enemy tank columns had to be blunted immediately, or the entire forces of Calonia would be vulnerable. The commander of JTF Mojave's XVIII Airborne Corps was in desperate need of maximum tactical air support immediately. He called on the Calonian Air Force, and within a short time a squadron of 18 TAC fighters was on hand for close air support against the invading armored force.

But this was a simulated war, and umpires must be present at an attack or crucial situation to score the success or failure of the tactical situation. They also determine losses, damage to equipment, etc. The absence of an umpire can mean failure to shroud a well-planned and rapidly developing or fast-moving tactical operation. In the Cadiz Valley engagement, the fast-moving tanks of the 2d Armored had outsped the umpires, leaving them far behind. Another quick decision was necessary. The corps commander, wanting to leave no doubt about the final results of his tactical air strikes against the tanks, called for air reinforcements. Within 15 minutes a second squadron of 12 fighters, operating from a distant base, was on the scene, giving the Calonia defenders a mass of 37 supersonic tactical fighters to smash 50 advancing tanks of the 2d Armored Division. The results were definite—the invading force was destroyed and the flank of Calonian forces was protected.

The odds were very uneven, of course: 37 fighters against 50 tanks. But the situation was desperate, and time was a factor. The high mobility of supersonic aircraft was the means of providing overpowering odds within minutes. Then, too, the missing umpires had to be convinced. General Meyer, Chief Controller (Umpire), explained the situation: "It would not be possible or desirable to mass an effort of this size against each and every ground target. We must have sufficient land combat forces to deal with most threats of this kind, but we know that we have the means to deal with a major emergency, such as occurred in the Cadiz Valley."

A new technique, recently developed by the Air Force and tested in a tactical situation for the first time during Desert Strike, helped to give the tactical fighters more punch during this encounter with the 2d Armored Division and was an important factor in the victory as well as a surprise to the invading forces. It was perhaps even more important, though less spectacular, than the rapid massing of tactical air power inasmuch as it gave the fighters limitless "staying power" over their ground targets.

Miles above the ground battle in the Cadiz Valley, aerial tankers of the Strategic Air Command and North American Air Defense Command were circling. Air National Guard and Tactical Air Command fighters, giving close air support to the Calonian ground forces, pressed the attack to the limit of their fuel reserves. Then, instead of returning to base, they climbed to the SAC tankers, refueled, and returned to the attack. In every war and training exercise in the past when a fighter aircraft began to run low on fuel, the pilot was forced to break off the fight and return to base. Often this meant discharging the rest of his ammunition against targets of opportunity on the way home or landing with it unused. This was not the case in Desert Strike.

More than 8 million pounds of jet fuel were transferred in aerial refuelings during Desert Strike. At no point were attacking "enemy" fighters able to "destroy" enough of the tankers to halt air refueling operations. One F-100 operating from Biggs AFB, Texas, refueled five times from a KC-135 and was airborne for 6 hours 20 minutes.

Another advancement over earlier warfare techniques used in Desert Strike for the first time was night tactical air warfare. During World War II and the Korean War tactical air operations were limited largely to the daylight hours. In Desert Strike large-scale tactical air operations were carried on by Calonian defenders at night in the application of a new tactic, dubbed "Night Owl." This technique consists of a continuous attack by flare-equipped jet fighters. The flares used are so far advanced over those of World War II and Korea that they can light an area as large as an air base. Each fighter element explodes a new flare as it completes its attack, illuminating the target for the next element.

The reconnaissance essential to identify and assess the importance of such targets was gathered, day and night, by TAC RB-66 and

*The M-60 machine gun (above) mounted in anti-aircraft configuration. . . . Even by the dark of night swift-moving M-60's of JTF Phoenix's 2d Armored Division invaded JTF Mojave territory.*

RF-101 aircraft using photography and more exotic infrared and electronic means. A complex up-to-date system of strobe lighting equipment was used on two RB-66B aerial reconnaissance aircraft flying night photoreconnaissance missions out of Norton AFB, California, for JTF Mojave. The light system is installed in the aircraft bomb bay, and each flash has a duration of one-thousandth of a second. It is set off when the pilot triggers the camera shutter. More than 35,000 watts of electricity flow into each light, providing enough illumination for clear aerial photographs of enemy ground targets.

### *counteroffensive*

Early on the morning of 21 May (D+4) Exercise Desert Strike escalated into nuclear warfare as the Calonian Air Force launched the first simulated nuclear attack of the war. At about 0500, Nezonan air bases at Luke, Davis-Monthan, and Yuma in Arizona, Biggs in Texas, Hill in Utah, and Nellis in Nevada were struck with nuclear weapons by tactical fighters. Succeeding strikes destroyed the bridges across the Colorado River at Needles and north of Davis Dam. Finally, strikes were directed against the advancing columns of the 2d Armored Division in the vicinity of Cadiz and Bagdad. The results of these attacks were decisive: Luke—out of action for 24 hours and severe damage for 8 hours to 2 fighters and 19 reconnaissance aircraft; Nellis—extensive damage to 3 fighters and to hangars, buildings, and supplies; Biggs—severe damage to 2 fighters and extensive damage to vehicles; Davis-Monthan—base out of action for 24 hours, severe damage to 12 fighters, and extensive damage to vehicles; Hill—minor damage; Yuma—severe damage to fighters and extensive damage to vehicles, supplies, and petroleum stores.

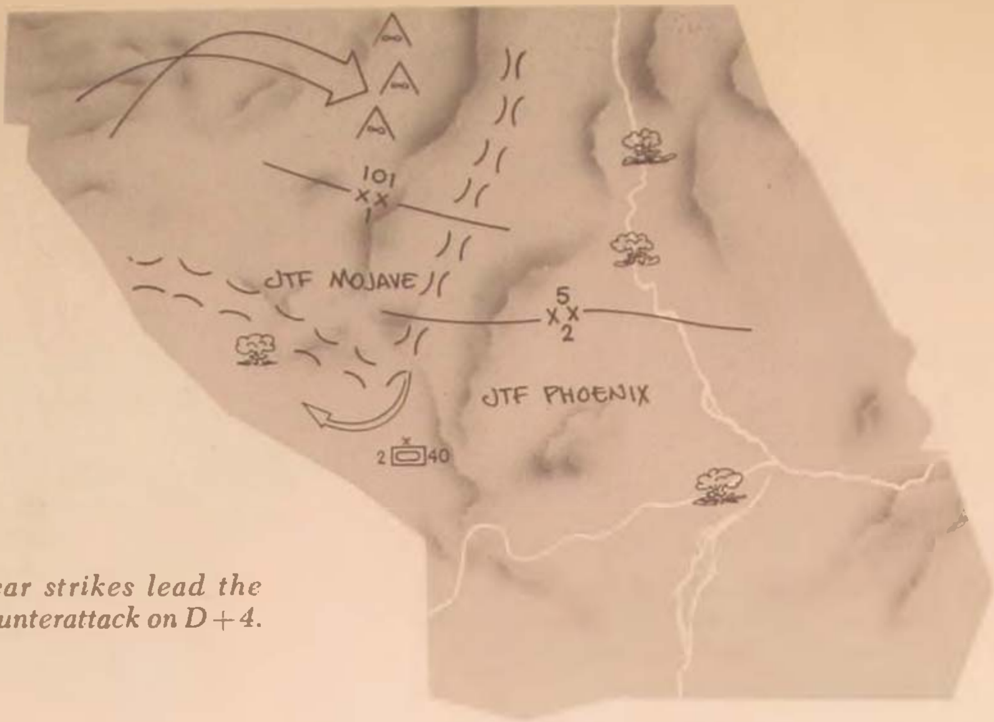
The decisive victory of the Calonian Air Force over the 2d Armored Division's heavy tanks in the Cadiz Valley on 20 May seemed to trigger a chain of events in which the JTF Mojave evidently decided to go all out to turn the tide of battle. In addition to nuclear strikes by fighter aircraft on JTF Phoenix's air bases on 21 May, a major threat in the southern sector was averted on the same day when nuclear strikes by Honest John missiles on the 2d Brigade, 2d Armored Division, caused this force to withdraw 25 kilometers to organize and recover. The sting was definitely felt by the invading forces, and JTF Mojave sensed a change in the tide of battle and threw additional reserves into the conflict and at the same time began mobilizing additional National Guard and Reserve forces.

During this period two airborne brigades were airlanded at assault airstrips to reinforce the Mojave defensive line. Over 85 C-130 aircraft airlanded 8000 troops and 3500 tons of equipment in the forward combat area in less than 36 hours, using a total of three strips (Map 3). The primary assault landing strip used was 15-mile-long Bristol Dry Lake, on which the C-130's practically selected their own runway. Using a unique system on this strip, the C-130's touched down on one side of the lake, made a 90° right turn, offloaded, turned left again, and took off. This system permitted a touchdown rate of one aircraft every two minutes.

The Nezonan Air Force was capable of striking back, of course. About noon on 21 May simulated nuclear weapons hit Calonian air bases at McClellan, Mather, Hamilton, Lemoore, Edwards, Palmdale, Oxnard, Norton, and George, all in California. The strikes were not decisive because Nezona's air capability had been reduced earlier by the Calonian forces' attacks. Both sides were then engaged in nuclear war, but Nezona forces were being pushed back off Calonian soil as a result of the initial devastating nuclear surprise attack.

On Thursday 21 May the Prime Minister of Calonia, General Nathan Twining, issued the following explanation for Calonia's initiating the use of nuclear weapons in its attack on Nezonan air bases and battlefield targets:

> Nezonan forces in overwhelming strength launched a two-pronged attack against Calonia Sunday and throughout Monday. As the world knows, this attack was unprovoked and unwarranted. When Calonia publishes the record of correspondence between the respective war cabinets, which Calonia terminated on Monday




*Map 3. Nuclear strikes lead the JTF Mojave counterattack on D+4.*

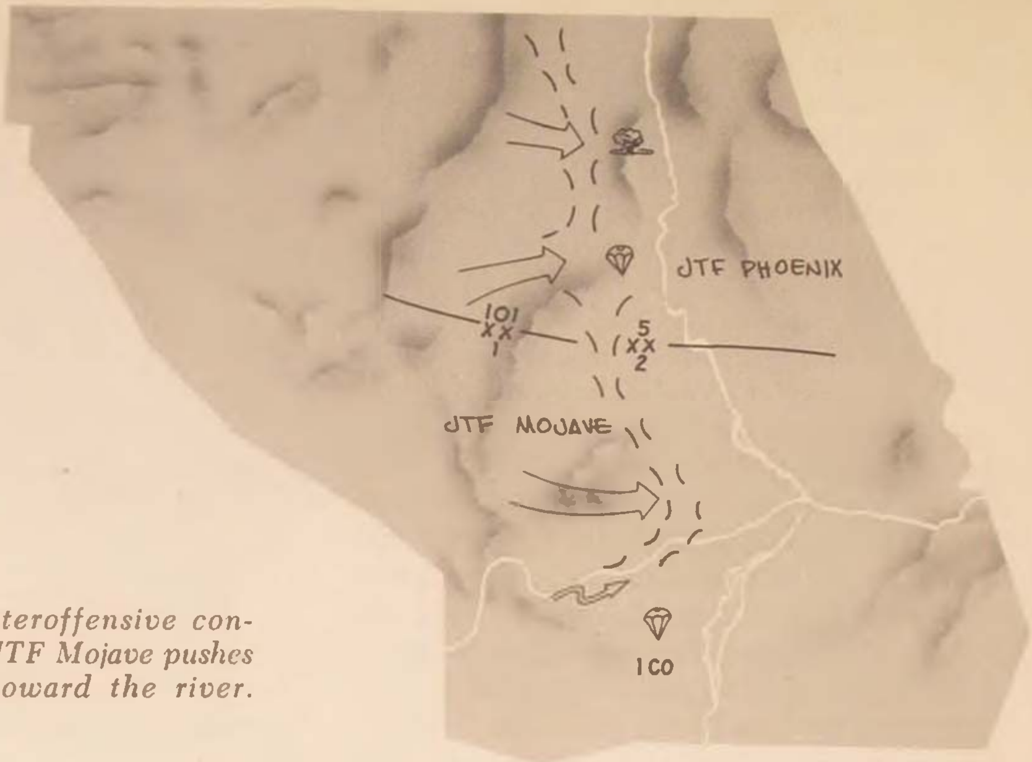
after Nezona duplicity was conclusively established, the world will appreciate that Nezona's act of naked aggression must, along with its perpetrators, be condemned and defeated. To allow such aggression to succeed, to permit Nezona to gain and hold one square inch of Calonia territory, would be to repudiate the values of the civilized world and the moral standards of the Organization of Western States.

In an effort to stem Nezonan attack and to mount our own counterattack, we have found it necessary as a last resort to utilize nuclear weapons. We informed the Secretary-General of the OWS on Monday that we would make every effort to confine the conflict to the tactical battlefield and to avoid escalation to nuclear weaponry. We held out as long as possible and authorized their uses yesterday afternoon. We have employed small weapons against military targets only, have authorized air bursts only in an effort to minimize fallout, and have instructed our commanders to take every precaution to protect non-combatants, Calonians and Nezonans alike. We are informed that fallout has been minimum and that Calonians can go about their daily tasks without fear of hazards to their health.

At noon on D+6, after a 24-hour administrative break, JTF Phoenix resumed its attack, and by the morning of D+7 it had successfully penetrated the Mojave defenses in two areas. By 1500 hours on D+7 the Phoenix attack stalled because of overextended lines of communication. JTF Mojave seized this opportunity to launch a counteroffensive to drive Phoenix back across the river.

At 0620 on D+8, a brigade of the 101st Airborne Division was parachuted 30 miles behind Phoenix lines to seize a critical pass and await the linkup of the armored forces (Map 4). A total of 67 C-130 aircraft was employed in this drop, 27 carrying troops, 40 carrying heavy drop. This was a very successful operation, with only one abort and minimum injuries to the paratroopers. A follow-up airdrop ran into difficulty when attacking Phoenix fighters struck the staging base while the airborne troops were loading, destroying over 31 aircraft and inflicting heavy casualties on the crews and airborne troops.

SAC KC-135 tankers, attached to each JTF, flew maximum effort during this period to permit deep penetration by fighters on counterair missions. On D+8 Mojave tankers completed over 150 mid-air refuelings in support




*Map 4. The counteroffensive continues on D+8 as JTF Mojave pushes Nezonan forces toward the river.*

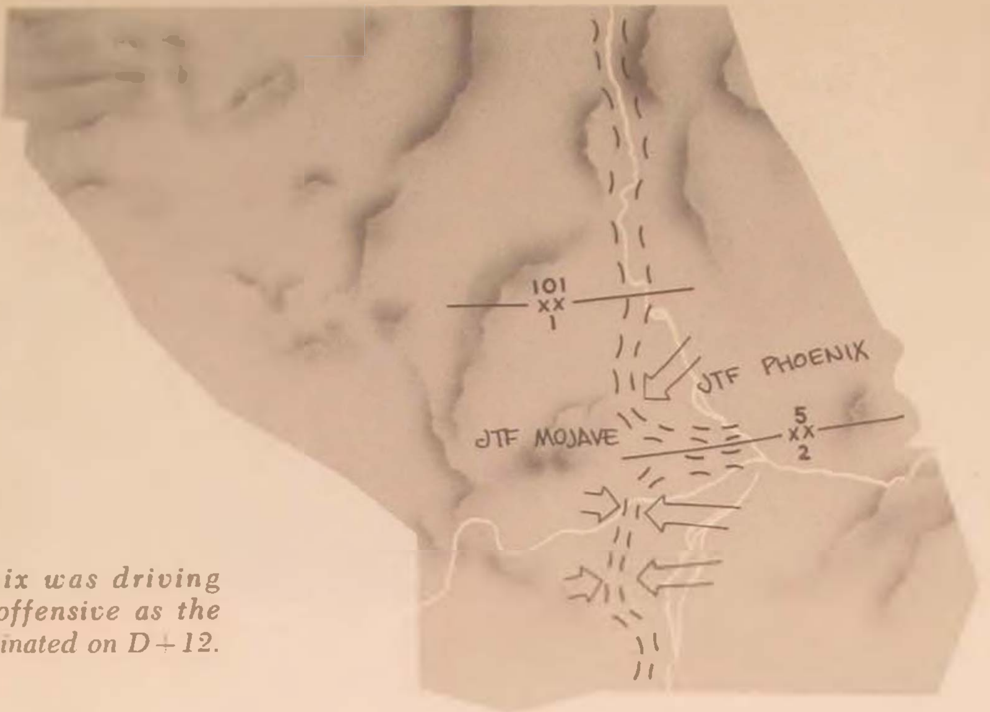
of offensive actions.

By dusk on D+8 Mojave had successfully recaptured a bridge over the Colorado River and had forced Phoenix into a full withdrawal. In the north the attack by the 101st Airborne Division drove the opposing 5th Infantry Division back across the river into its homeland. In the south, however, the two armored divisions continued to clash west of the river.

The Mojave Reconnaissance Squadron (RF-101 and RB-66) was used quite extensively during this period to locate bypassed Phoenix units attempting to extricate themselves. This was a particularly difficult mission, since these forces had to be distinguished from friendly Mojave ground forces.

JTF Mojave continued to push hard against Nezonan forces after the initial nuclear strike gave it an edge, and on 26 May (D+9) the 5th Infantry Division of JTF Phoenix started to withdraw across the Colorado River. Also on that date the Nezonan Air Force launched an all-out nuclear attack on air bases of Calonia in addition to five nuclear strikes against enemy positions on the battlefield. Calonian forces continued their attacks with nuclear weapons against the strong points of Nezona, but they were caught off balance by the increase in the tempo of attacks launched by JTF Phoenix. Further adding to the new punch of Nezonan forces was the reconstitution of both land and air forces by expanding mobilization.

THE PARTICIPANTS in Joint Exercise Desert Strike were aware that the planned deadline for the cease fire was drawing near, but they did not know the exact hour. Each JTF commander, with his staff, was trying desperately to register with the umpires, score points, and win the exercise. They tried to pull surprises, catch the opponent off guard and off balance, gain ground by use of nuclear weapons or mobile maneuvering or concentration of force. JTF Phoenix fought to keep the Calonian forces off Nezonan soil. All these efforts brought about major changes in the tactical situation right up to the cease fire at 1700 on 29 May. At that time almost all elements of the 5th Infantry Division had recrossed the Colorado River, reinforcing the northern sector of the




*Map 5. JTF Phoenix was driving hard to regain the offensive as the desert war games terminated on D+12.*

pocket held by the 2d Armored Division. The exercise controllers believed that the tactical commanders had had ample opportunity for free play and that the objectives of the exercise had been achieved to a degree equal to or surpassing all expectations. At that point there was no need to prolong the exercise and mount the cost (Map 5). Air and ground units received outstanding training in joint operations associated with the simulated use of both conventional and tactical-nuclear weapons. This exercise provided a rare opportunity for evaluating tactical air action in support of a highly fluid, fast moving ground situation. Tactical air action in support of ground forces was extensive. The Mojave ground forces requested 1636 sorties, of which 1628 were flown and 1500 judged effective. Phoenix ground forces requested 1246 sorties, of which 1163 were flown and 1080 judged effective.

"Out of this huge Desert Strike effort," General Meyer said, "we have advanced the defense of the United States, while identifying many areas in which much greater concentration and study is required. As progress is made in those fields, it must be tested in field exercises such as Desert Strike. There is simply no adequate substitute for this type of realistic evaluation."

General Adams, in a statement summarizing the exercise, said, "It will be a matter of months before all the data obtained during the course of Joint Exercise Desert Strike can be properly evaluated. Complete and sound conclusions based solely on what one or a few men can derive from necessarily limited observations are not possible at this time. There is however no question in my mind that through a process of careful assimilation and evaluation of data we shall obtain from this maneuver guidance far beyond anything we had anticipated a few weeks ago." In his praise of the reserve forces General Adams added, "I am gratified by the results achieved by reserve component units participating in the Exercise. We literally have a 'gold mine' of information which when refined will provide us a large body of highly valuable knowledge for use throughout the services."

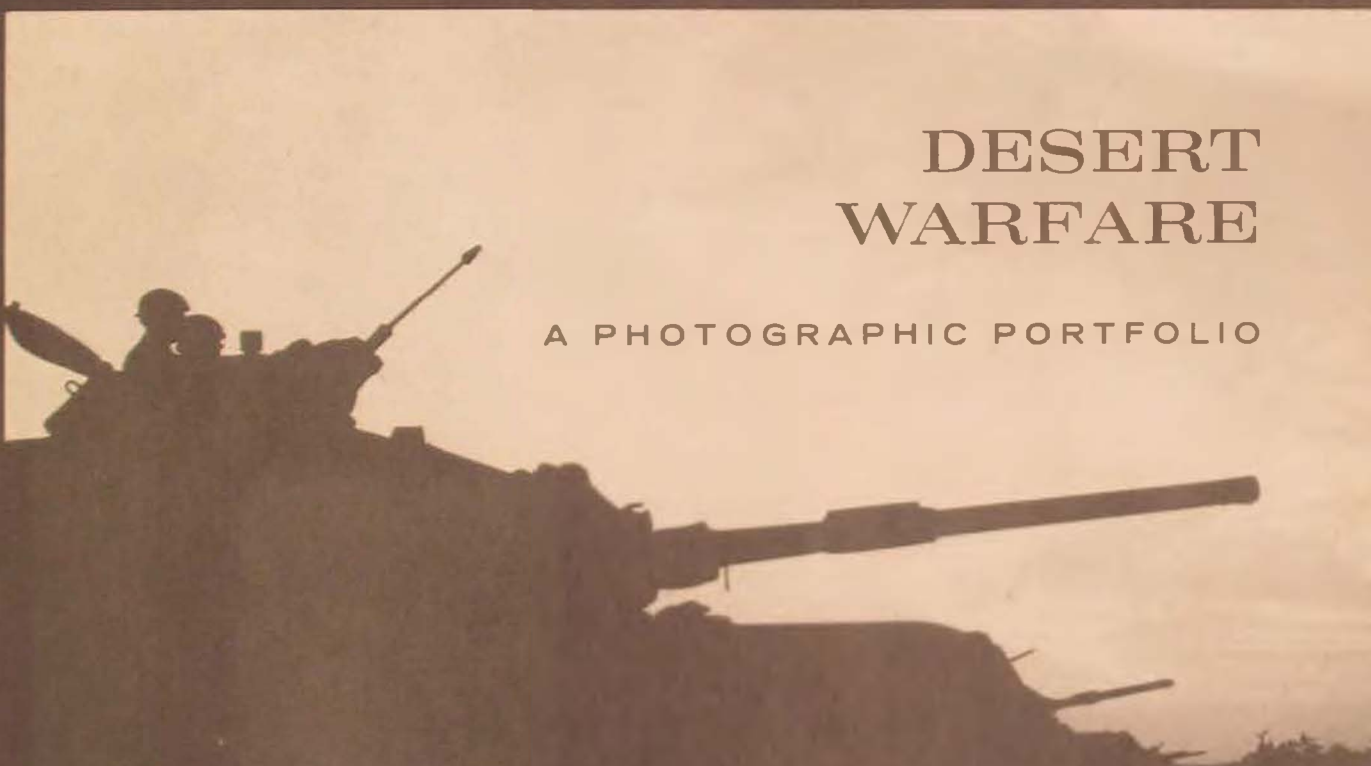
Reliable sources have estimated that Exercise Desert Strike cost about $54 million, the costliest exercise since World War II.

Asked why the exercise was considered worth the outlay of funds, Pentagon officials cited these reasons, among others:

> It is the first time since World War II that we have been able to get two armored divisions into an exercise maneuver area in the United States where they could operate as freely as required for proper armor field training.
>
> The exercise also gave us a chance to simulate realistically the employment of tactical nuclear weapons. This let us better explore tactical use of nuclear weapons in a limited war situation.
>
> Joint Exercise Desert Strike was not only a thorough test of men and equipment, but also an ideal opportunity to test and further improve several operational concepts for joint air-ground operations we have been developing and improving over the past several years.

# DESERT WARFARE

A PHOTOGRAPHIC PORTFOLIO



## Desert River Crossing

**Ground forces of Nezona had to cross a river before they could challenge the forces of Calonia and of Nature in the vast Mojave Desert.**

*A smoke screen is set off to hide an assembly area for vehicles and soldiers of JTF Phoenix preparing to cross the Colorado River into Calonia.*

*After crossing the river in rubber rafts by moonlight, National Guardsmen climb the "enemy" embankment. . . . M-116 armored personnel carriers swim the river and head for the "front," leaving the Nezonan homeland far behind.*

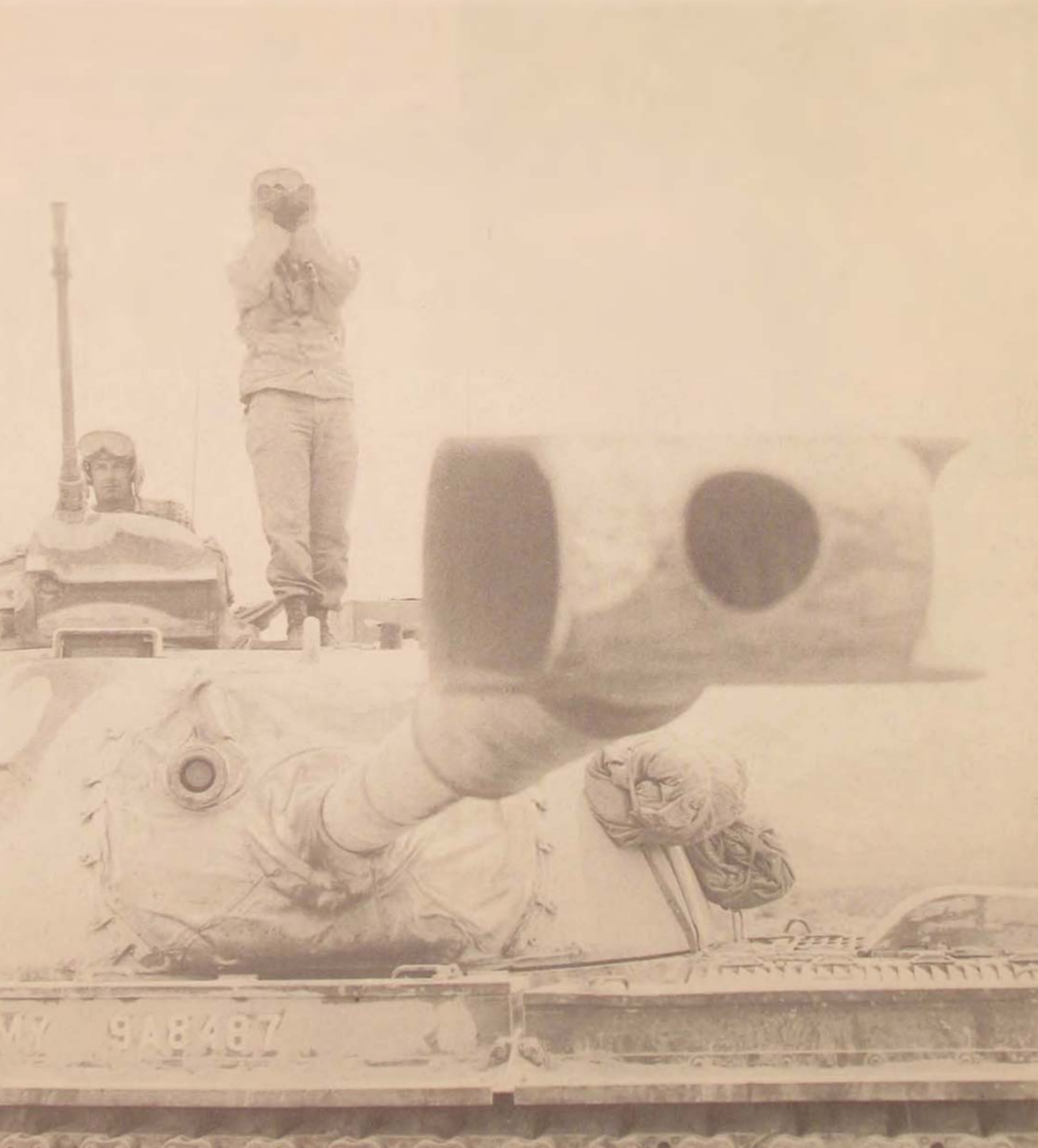
*Army engineers lift pontoons into the Colorado River. . . . The bridge company fits raft sections over pontoons before laying the trackage for tanks.*

*Pontoon bridge construction proceeds from both sides toward the middle. . . . M-60 main battle tanks of the 2d Armored Division are first across the newly completed floating pontoon bridge.*

## Desert Ground Warfare

**U.S. Army's iron monsters had plenty of maneuver room in the Mojave Desert, where sun, sand, and wind were a real threat in the mock war.**

*The task commander of the Calonia forces checks terrain for the best route through the Mojave.*



*Soldiers and airmen get ready for the day's work at a camouflaged bed site near JTF Mojave headquarters. . . . A JTF Mojave vehicle park lies hidden in the foothills of the Old Dad Mountains north of Amboy, California.*

*An M-60 of 2d Armored ("Hell on Wheels") Division, its 105-mm howitzer pointing the way, plows into a sea of desert dust. The 2d led the Nezonan attack on Calonia. . . . M-116 armored personnel carriers of JTF Phoenix move Nezona's forces into battle.*

# Desert Air Warfare

**Fighter aircraft made it hot for ground forces round the clock as new techniques enabled the first large-scale night operations in close air support.**

*Rows of equipment parachute-packed for airdrop with 101st Airborne Division paratroops await loading onto C-130 transports at Kerns County Airport, Mojave, California. The trailers are backed to the aircraft, and the pallets are pulled over rollers for easy onloading.*

*A Calonian F-100 Super Sabre makes a low-altitude simulated bomb run against JTF Phoenix troops along Route 66 near Amboy, California. . . . A C-130 lands on impacted runway prepared by Army engineers in the bed of Bristol Dry Lake.*

*An Air Defense Command F-101B Voodoo prepares to take off on a Desert Strike interceptor mission. . . . On the helicopter pad at Headquarters JTF Mojave, an Air Force H-19 and Army UH-1B meet.*

*An F-84 Thunderstreak zooms upward after a bomb run against Nezonan armored columns.*

# INCENTIVE CONTRACTING

Colonel Jack W. Coleman and
Major David C. Dellinger

TODAY, as has been true historically, defense procurement emphasis is on competitive procurement. True competition usually results in a firm-fixed-price contract under which the parties have in effect agreed that the contractor has assumed full responsibility, in the form of profits or losses, for all costs under or over the firm fixed price. Unfortunately, a large majority of the Department of Defense procurements (particularly research, development, test, and evaluation) do not lend themselves to the ideal competitive situation. The nature of many of the weapon system procurements results in cost-type contracts with fixed-fee arrangements (cost plus fixed fee—CPFF). In this type of contract the contractor has little if any stake in the outcome. Since the fee is fixed, contractor cost responsibility is minimal, and in effect good performance and bad performance are equally rewarded. Thus there is little incentive to control costs or improve performance and schedules.

Both the Government and the contractor should be concerned with having the profit motive work for the truly effective and economical performance so vital in the interest of national defense. The objective should be to ensure that the efficient producer is rewarded by high profits, the mediocre producer by moderate profits, and the poor producer by low profits or losses. One of the objectives of the Department of Defense in its recent efforts to define more clearly the various categories of research and development and its concentration on realistic project definition is to contribute to the achievement of such a profit objective. Success in these efforts will permit the use of contracts that will also contribute to the same overall objective. By the judicious use of contract incentives on cost, performance, and schedule, it is believed that the Government can establish the desired emphasis and criteria under which achievement can be considered outstanding, mediocre, or poor. When profits are tied to contract results, contractor motivation will be maximized. While industrial reaction to Governmental efforts to promote efficiency through contractual incentive arrangements has been mixed, one spokesman has stated: "Here again use of fear, inspirational leadership, appeal to pride and patriotism, in appropriate cases, can have an effect, but basically the appeal to the pocketbook gets the mostest for the leastest."[1]

As deficiencies have been recognized in various types of contracts,[2] greater emphasis and interest have been placed on the use of incentive provisions within such contracts to correct these deficiencies and actively encourage the reduction of costs to the Government. The concept is not new,[3] but the emphasis is new and is a key element in the evolution taking place in procurement policy and practice. Various management consultant firms and Governmental committees, in their analysis of this problem of promoting efficient contractor performance, have recommended greater use of incentive contracts. One such group stated: "It is believed that permitting contractors to be rewarded pricewise and to share in savings for good performance and economy of operation would be an effective means to improve procurement."[4] The Department of Defense has defined the incentive principle as follows:

> The incentive principle holds, in brief, that a contractor should be motivated, in calculable terms (i) to turn out a product that meets significantly advanced performance goals, (ii) to improve on the contract schedule up to and including final delivery, (iii) to substantially reduce the costs of the work, or (iv) to complete the project under a weighted combination of some or all of these objectives.[5]

Emphasis is on getting the lowest total price consistent with performance and delivery objectives rather than on limiting a contractor to the lowest possible profit.[6]

While there are influential proponents of the incentive concept, the concept also has influential opponents. Chairman Vinson of the House Armed Services Committee is on record as opposing the use of incentive contracts because the increased fee can result from poor negotiation of target costs (which form the basis for determining reward or penalty) as easily as from increased operational efficiency. Vice Admiral Rickover, in testimony before the House Defense Appropriations Subcommittee on 23 May 1963, expressed the same criticism and challenged the widespread use of incentive contracts: "The contractor knows more about how much the item costs than the government, and can set a high initial price. The contractor can then say his lower costs were due to efficiency . . . and the government rewards him for these so-called cost savings by paying him a higher profit."[7]

### *elements of incentive contracts*

Generally, two broad types of contracts form the basic contractual vehicles for incorporating incentives. These are the fixed-price-incentive-fee contract (FPIF) and the cost-plus-incentive-fee contract (CPIF).

Armed Services Procurement Regulations define FPIF and CPIF contracts and restriction on fee as follows:

> The fixed-price incentive contract is a fixed-price type contract with provisions for adjustment of profit and establishment of the final contract price by a formula based on the relationship which final negotiated total cost bears to total target costs.
>
> The cost-plus-incentive-fee contract is a cost-reimbursement type contract with provision for a fee which is adjusted by formula in accordance with the relationship which total allowable costs bear to target cost. . . . The provision for increase or decrease in the fee is designed to provide an incentive for maximum effort on the part of the contractor to manage the contract effectively.
>
> 10 U.S.C. 2306 (d) provides that in the case of a *cost-plus-fixed-fee* [emphasis added] contract the fee shall not exceed ten per cent (10%) of the estimated cost of the contract, exclusive of the fee, as determined by the Secretary concerned at the time of entering into such contract (except that a fee not in excess of fifteen percent (15%) of such estimated cost is authorized in any such contract for experimental, developmental or research work and not in excess of six percent (6%) of the estimated cost, exclusive of fees, . . . in contracts for architectural or engineering services relating to any public works or utility projects.) [ASPR has restricted maximum fees in CPIF contracts to these same tenets.—ASPR 3-405.4(c)] As to fee limitations on subcontracts, see ASPR 3-807.10(d).[8]

The following elements, by type of contract, are subject to Government and contractor negotiation before award:

| *Element* | *FPIF* | *CPIF* |
|---|---|---|
| Target cost | x | x |
| Target profit | x | x (fee vs. profit) |
| Ceiling price | x | |
| Sharing formula | x | x |
| Maximum fee | | x |
| Minimum fee | | x |

A discussion of certain of these elements is necessary before proceeding.

*Target Cost.* As early criticism has indicated, the most critical aspect of incentive contracting is to arrive at a realistic target cost. Unfortunately, since target cost is an estimate, a forecast of the future, it will inevitably reflect some degree of uncertainty as to the specific outcome of the contract. The target cost should represent the best, mutually determined estimate of what actual costs will be when the contract is complete; or, stated another way and borrowing from statistics, target cost should represent that figure at which there is an equal probability of costs being either under or over. It goes without saying that these are not easy criteria to meet. However, with more realistic project definition and such procedures as program evaluation and review technique and PERT/Cost, it is not impossible. It should be recognized that all is not lost even if the criteria cannot be completely complied with. The confidence that either or both parties have in target will affect negotiation of the other elements. Statistically, the exact cost estimate, while important, gains significance as the range of possible costs narrows towards the fulcrum (or target cost in this case), because confidence varies inversely with such range. If the Government has less than the desired confidence in target (e.g., there is a greater chance of overrun than underrun), it can negotiate stronger incentive provisions and the type of contract that will minimize this aspect.

In arriving at a mutually agreed-to target cost, the negotiations of necessity will also provide data to support each party's confidence level and the extent of cost range. The lower limit of this range would reflect the most optimistic or lowest practical cost for accomplishment, whereas the upper limit would reflect the most pessimistic practical cost for accomplishment. This would in effect establish the range of confidence. DOD has indicated that, "When the upper limit is less than 10%, the Government should concentrate on negotiation of a firm-fixed-price arrangement. For an upper limit between 10 and 25 percent, the fixed-price incentive type will usually be appropriate. When confidence decreases to a level beyond 25 percent, it will usually be necessary to shift to the CPIF form."[9] (Skewing of range can be compensated for through the incentive formula.) Factors to be considered in arriving at these limits are as follows:

(1) The nature of the work. The higher the ratio of development to fabrication, the greater the uncertainty.

(2) Past experience. No previous experience in type of work or poor cost experience in forecasting will increase the uncertainty.

(3) Negotiation environment. If critical cost positions of each party are far apart (and not caused by misunderstanding of work statement), one (or both) is likely to have little confidence in the end result.

(4) Time available for development of estimate and negotiation. The more time permitted, the greater the confidence in the end result.[10]

The Vinson and Rickover criticisms concerning target costs noted earlier must assume that the Government can and does negotiate a better position in contracts which exclude incentive provisions. We are not aware of any analyses or studies that support such a conclusion. Rather, we believe that in many cases for many reasons the Government cannot negotiate the optimum cost (regardless of inclusion or exclusion of incentive features). However, it would still appear a distinct advantage to the Government to provide some incentive to get actual performance to correlate with a more efficient operation. For example, if the Government has negotiated the best position it can but this is not very good, it would still seem prudent to try to reduce total cost by some sharing arrangement. A share arrangement of 75/25 would mean that if the contractor is motivated to reduce costs below the excessively high target, the Government would recoup 75 cents of each dollar of reduction. While maybe not optimal, this is a more frugal position than would have been achieved without incentives, because there is considerable evidence that without some incentive the contractor will, at minimum, incur costs up to the dollar limit cited in the contract if it is other than a firm-fixed-price contract.

*Target Profit.* Target profit (or any negotiated profit for that matter), like target cost, has proved most difficult to arrive at in any realistic and satisfactory manner. This area, in terms of supporting documentation and time consumed in negotiations, seems to be taking more and more effort.[11] In many instances, after extensive negotiation, the resulting profit or fee has, by some coincidence, usually approximated the appropriate industry average. To make profit or fee more indicative of risk, Section III of Armed Services Procurement Regulation has been revised to incorporate a weighted guidelines concept which became effective 1 January 1964. Again, this concept is an effort to reward good performance and penalize mediocre or poor performance by having the profit objective reflect the total overall task to be performed and the risk assumed by the contractor.[12] Closely associated with this is the new DOD system for evaluating contractor performance.[13]

*Sharing Formula.* If target cost and expected range and target profit or fee and maximum-minimum fee are properly developed, then in effect the sharing arrangement has been predetermined. This is proper inasmuch as the most important determinant of the "share slope" should be the degree of risk inherent in the particular procurement situation. Further, share arrangements and thus slope can be tailored to meet specific conditions and do not have to result in a continuous straight line. For example, it may be desirable to have a relatively shallow share line, say 85/15 within a small range of target cost (if small deviations are unimportant), and steeper slopes for costs farther from target if large overruns are objectionable and it is desirable to encourage substantial underruns. (However, this so-called "plateau" effect should not be a "gimmick" to surmount impasses in the negotiation of target cost.)

### *maximum-minimum fee*

Obviously, the objective of maximum-minimum fee is to have a reward-penalty arrangement that will provide the contractor with a valid incentive to control costs. The incentive provisions should be so constructed as to be effective over the entire range of possible deviations from target cost. The Department of Defense indicates that the minimum and maximum fees and the fee adjustment formula should be negotiated so as to provide an incentive which will be effective over variations in cost throughout the full range of foreseeable variations from the target. Further, DOD suggests that when high maximum incentive fees are negotiated, it is proper (for control at the other end of the spectrum) to provide for a

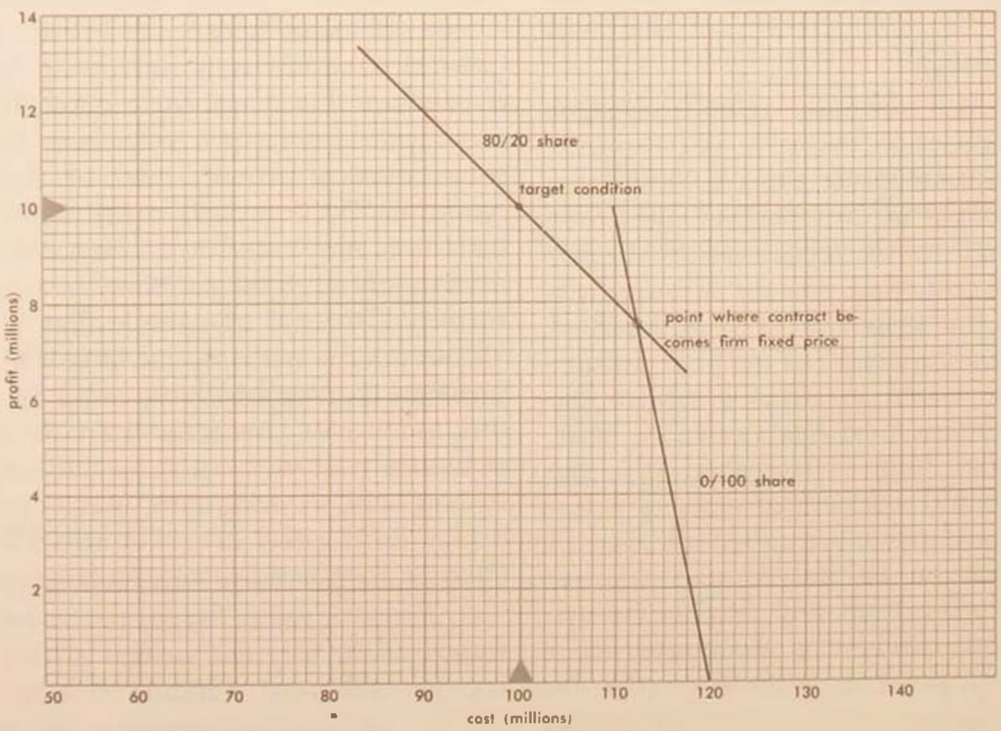



*Figure 1. Fixed-price-incentive-fee (FPIF) contract*

low minimum fee which may be a "zero" fee or a "negative" fee.[14]

### *fixed-price-incentive-fee contract*

In FPIF contracts, cost reductions or overruns from the target cost are shared by the Government and the contractor in accordance with a negotiated formula. The distinguishing feature of this form, however, is that of a fixed upper limit on the total contract price, i.e., cost plus profit. This feature has the effect of changing the characteristics of the contract to that of a fixed-price agreement. With this background it is desirable to portray briefly the conditions by type of contract. Assuming the following facts associated with an FPIF contract, one can graphically portray types of incentive arrangements. (Graphic portrayal has distinct advantages in that it permits quicker and greater understanding of the arrangement and any desired manipulation thereto. See Figure 1.)

Assume:

| | |
|---|---|
| Target cost | $100M̄ |
| Target profit | $10M̄ |
| Ceiling price | $120M̄ |
| Sharing formula | 80/20 |

To construct the graph:

a. Plot target cost against target profit.

b. Reduce (or increase) target cost by a certain number of dollars (e.g., $10M̄) and calculate the profit (e.g., by reducing cost $10M̄, i.e., to $90M̄), profit would equal $10M̄ + (20% × $10M̄) = $12M̄. Plot $90M̄ cost vs. $12M̄ profit to establish second point for straight-line share arrangement.

c. At some point, the share line changes from 80/20 to 0/100. To find that point graphically:

(1) Final point equals ceiling price, i.e., profit equals zero at cost equal to $120M̄.

(2) The second point is computed similarly to b, above, except that on a 0/100 share line any cost reduction equals a corresponding increase in profit to contractor. Assume reduction of costs from $120M̄ to $110M̄; then profit would be $10M̄. Plot $10M̄ vs. $110M̄ and draw straight line.

d. The intersection of the 80/20 and 0/100 share lines is the total dollar point where the contract starts operating as a firm-fixed-price contract. In the example this point is at $112.5M̄.* What would the total contract price be if costs equaled $90M̄? From the graph the fee can be determined by adding it to the actual costs to get the total price. The fee for $90M̄ of costs equals $12M̄.** Thus total price equals $102M̄.

Note that, as constructed, profit can range from a negative value (if actual allowable costs exceed ceiling) to a zero profit (if actual allowable costs equal ceiling price) to any positive amount on the share line (if allowable costs are less than ceiling price). The ceiling price, which represents the maximum amount the Government will pay, is a very desirable feature and, other things being equal, makes it preferable to a CPIF type.

### *cost-plus-incentive-fee contract*

Next, with the following assumed facts, it is possible to portray a CPIF contractual arrangement graphically.

Assume:

| | |
|---|---|
| Target cost | $100M̄ |
| Target fee | $ 10M̄ |
| Maximum fee | $ 13M̄ |
| Minimum fee | $ 7M̄ |
| Fee swing | ±$3M̄ |
| Sharing formula | 80/20 |

The same mechanics applicable to constructing the FPIF contract can be used here except that no ceiling price is involved and, instead, there are maximum and minimum fees. Under actual conditions the confidence level developed through analysis and negotiation would

*This may be computed mathematically as follows:

$$\text{Breaking Point X} = \frac{\text{ceiling price} - \text{contractor's \% share of target cost} - \text{target profit}}{1 - \text{contractor's \% share}}$$

$$\text{substitute:} \quad = \frac{\$120\overline{M} - .2\,(\$100\overline{M}) - \$10\overline{M}}{1 - .2}$$

$$= \frac{\$90\overline{M}}{.8}$$

$$= \$112.5\overline{M}$$

**This can be calculated based on sharing arrangement: $90M̄ actual costs is $10M̄ less than target; therefore, the contractor fee will be $10M̄ + (20% × $10M̄) = $12M̄.

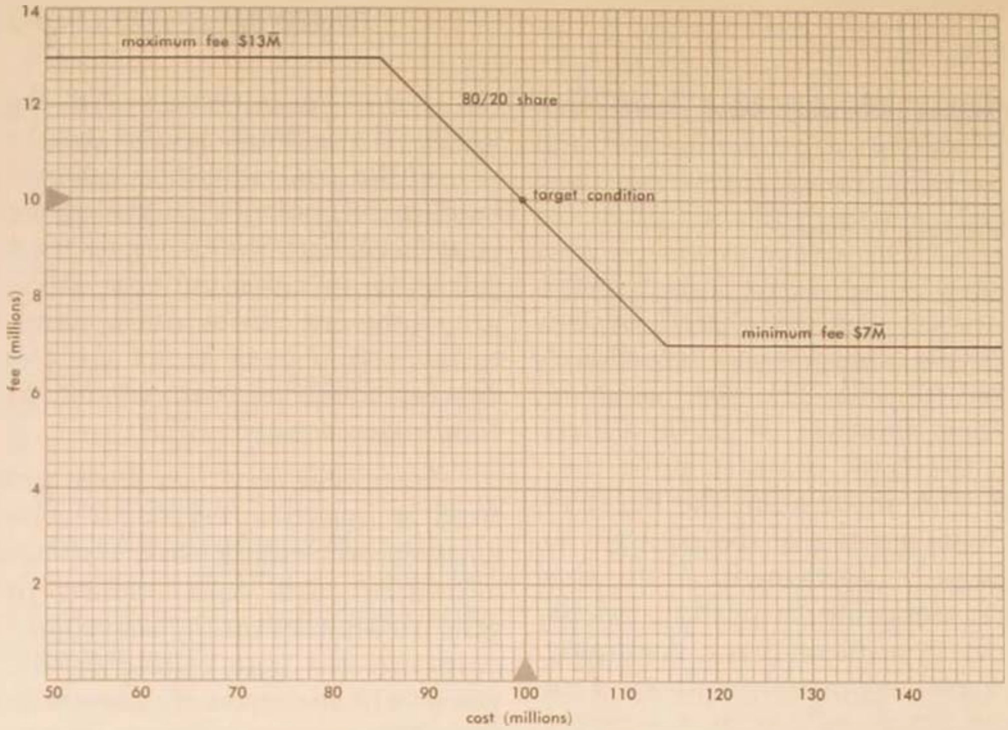



*Figure 2. Cost-plus-incentive-fee (CPIF) contract*

produce a range (most optimistic, most pessimistic, target cost), and extending upward from these costs to an intersection of the "max-min" fee lines should be the technique for actually determining the share formula. (If most optimistic and most pessimistic costs approximated $85M̄ and $115M̄, the share line would be as given above, i.e., 80/20.) What would be the total price of the contract to the Government if contractor costs equaled $112.5M̄? From the graph (Figure 2) you can find the fee at that cost, which is $7.5M̄,[*] giving a total contract price of $120M̄.

Note the major difference between the two contractual arrangements. The CPIF with a minimum fee becomes a cost-plus-fixed-fee contract when costs reach the point where minimum fee becomes applicable (i.e., if costs overrun target to point of minimum fee, no further penalties are imposed and the control incentive feature is nullified). As noted earlier, the FPIF contract reverts to a firm-fixed-price (FFP) contract, thus providing maximum control over incentive.

If it is desirable to have other than a straight line share arrangement, it is easily portrayed graphically; e.g., assume that at 10% plus-minus target cost it is desirable to have a 90/10 share arrangement with cost less than that sharing 75/25 and cost beyond that sharing 80/20. Further assume the same additional facts used above except that minimum fee is shifted to $5M̄. Figure 3 graphically portrays this situation. This contractual arrangement suggests that slight (10%) variations from target are acceptable, but the stronger incentive is to get costs below $90M̄ and a fairly good penalty if they exceed $110M̄ up to $130M̄, at which time the cost control incentive ceases.

### *multiple incentives*

In addition to the cost incentives already discussed, there is a growing emphasis on the need to provide an incentive to the contractor in the other major areas over which he has control, i.e., performance and schedule. These three broad areas—cost, performance, and schedule—are involved in any satisfactory contract completion, and emphasis on one to the exclusion of the others risks loss of control regarding the desired objective of the Government. After all, the timely delivery of a weapon system evidencing required technical capabilities is no less an objective than cost. The

[*]The fee can be calculated based on the sharing arrangement. E.g., if costs exceeded target by $12.5M̄, this would cost the contractor $2.5M̄ of fee (20% × $12.5M̄), making fee $7.5M̄.

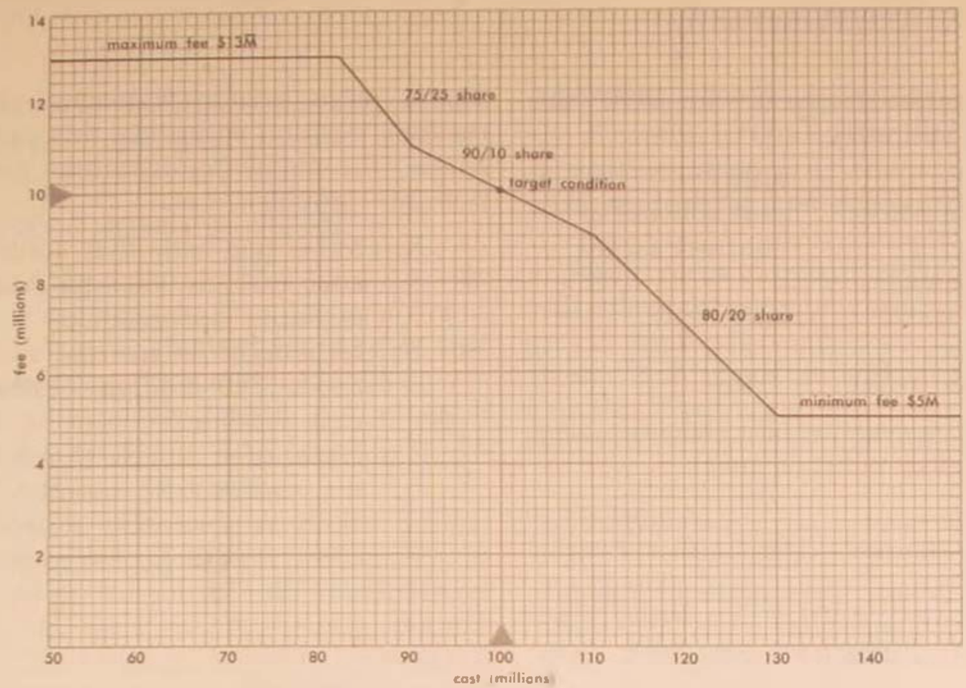



*Figure 3. CPIF contract with cost/share variations*

Department of Defense has indicated that a properly structured multiple-incentive contract should serve two basic purposes:

> First, it should motivate the contractor to strive for outstanding results in all three incentive areas; . . . Second, if it becomes apparent to the contractor that outstanding results cannot be achieved in all areas, the incentive structure should compel decisions as between costs, time and performance that are in consonance with the overall procurement objectives of the Government.[15]

Performance incentives (reward/penalty) normally are associated with such things as weight, speed, reliability, range, payload, etc. Assuming good project definition,[16] the technical aspects of the equipment and procurement should be clear. This will form the basis for determining those elements of performance where emphasis is desirable, defining what constitutes superior technical achievement, a reasonable target, exactly how performance will be measured, and the relative importance of each characteristic. Like cost targets, performance targets must be reasonable, and if trade-offs become necessary between performance elements, the incentives should be structured so that contractor emphasis is in consonance with Government objectives.

Historically, most schedule incentives have been negative in nature. That is, no reward for early delivery but penalties for failure to perform on time. However, if early delivery of finished work has a value to the Government, there is no reason why a positive incentive arrangement should not be included.[17] The success of schedule incentives, as is true with all incentives, is largely dependent upon the development of realistic targets. Secondly, the range of incentive effectiveness must be established[18] (i.e., the time period preceding and following these targets during which the incentive will be operative).

At best, structuring a multiple-incentive matrix so that the most profitable trade-off decision for the contractor will always coincide with the desired objectives of the Government is most difficult. Technically, the relationship of these elements (cost, performance, and schedule) is much more complex than is recognized by most, and there is considerable question as to whether these relationships can in fact be related in some effective way. Consequently, extreme caution must be exercised in developing a multiple contractual arrangement, or more harm than good may possibly be done.

As an example of multiple incentives and their graphic portrayal, assume a CPIF contract and the following facts:

| | |
|---|---|
| Target cost | $\$100\overline{M}$ |
| Target delivery | 24 months after contract award |
| Performance target-speed | 1000 mph[19] |
| Target fee | $\$7\overline{M}$ (7%) |
| Target fee swing | $\pm\$8\overline{M}$ |

The ranges of incentive effectiveness have been determined to be as follows:

| *Incentive Element* | *Required for Max. Reward* | *Target* | *Required for Max. Penalty* |
|---|---|---|---|
| Cost | $\$70\overline{M}$ | $\$100\overline{M}$ | $\$130\overline{M}$ |
| Performance | 1050 mph | 1000 mph | 950 mph |
| Schedule | 21 months | 24 months | 27 months |

Further, the Government believes that performance should be weighted 50%, schedule 10%, and cost 40%; i.e., the fee swing should be applicable as follows:

| | | |
|---|---|---|
| Performance | 50% | ($\pm\$4.0\overline{M}$) |
| Cost | 40% | ($\pm\$3.2\overline{M}$) |
| Schedule | 10% | ($\pm\$0.8\overline{M}$) |

With these facts and assuming a simple linear relationship, the contractual arrangement can be portrayed graphically (Figure 4). The Government must have carefully analyzed the matrix being established to ensure that the weights assigned do produce incentive combinations that promote the desired objectives.

To structure the incentives properly so that they motivate the contractor towards the desired goal, it is critical that the incentive values for each element (in this example, 50%, 40%, 10%) be determined in light of and be consistent with actual technically feasible "trade-off" possibilities among the several areas which are available to the contractor. The "trade-off" function represents the technical constraints on the contractor, i.e., the actual combinations of performance, cost, and schedule which are possible or seem feasible to the contractor. Without knowledge and consideration of the "trade-off" function in structuring the incentives, there is no assurance that the desired Governmental objective (increased performance in this example) will be the same objective selected by the contractor. To facilitate a more precise statement of the contractor's position regarding this particular example, the following notations and calculations are provided. Let:

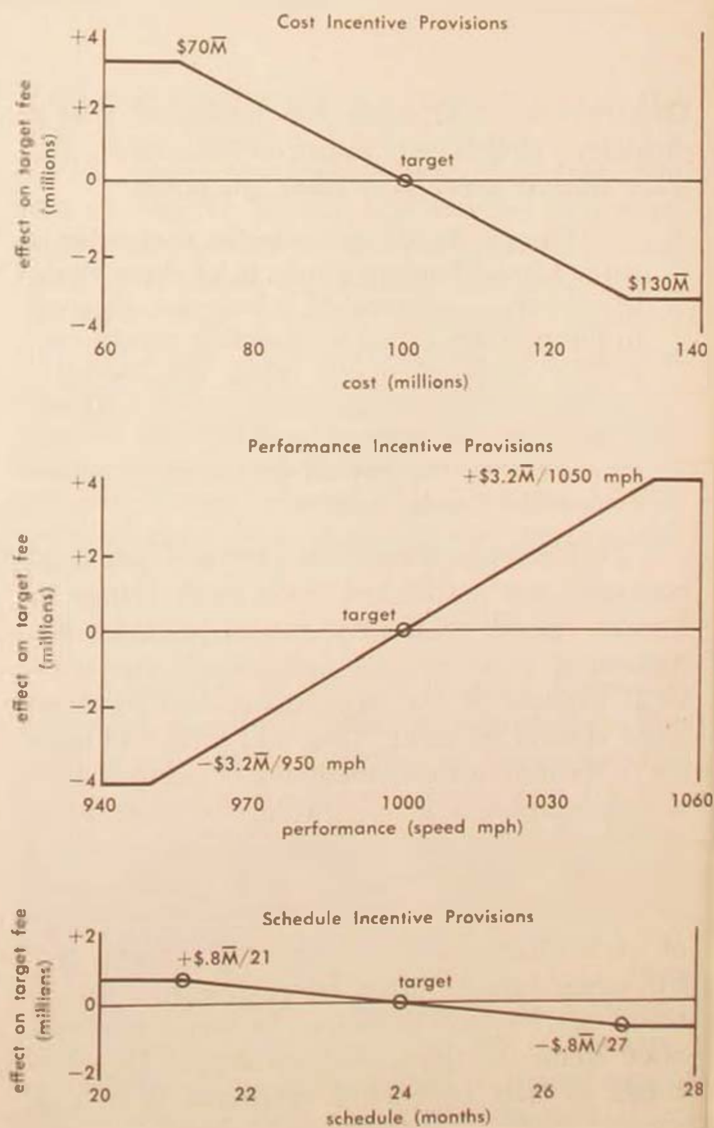
X = Miles per hour that actual performance exceeds 950 mph (minimum acceptable performance)

Y = Millions of dollars that actual cost exceeds $70 million (estimated best cost possible)

Z = Number of months that actual schedule exceeds 21 months (estimated shortest obtainable schedule)

$F_T$ = Total fee (target fee ± incentive).

*Figure 4. CPIF contract with multiple incentives*



In terms of these variables, the contractor's total fee may be calculated by the following formula:

$$F_T = .08X - .10666Y - .26666Z + 7^{*}$$

provided that the values of X, Y, and Z are in the incentive region; i.e., X is between 0 and 100 mph, Y is between \$0 and \$60 million, and Z is between 0 and 6 months. To illustrate, note that if all incentive factors are on target ($X=50$ mph, $Y=\$30\overline{M}$, $Z=3$ months), the fee $F_T=\$7\overline{M}$ is as it should be.

To illustrate the impact of the actual "trade-off" function, it is first necessary to determine what the "trade-off" possibilities are. In an actual situation one possible method for making this determination is to request the contractor to provide forecast performance for several combinations of cost and schedule (with analysis by the Government as to reasonableness). For this illustration assume that the contractor submits the following:

| *Cost* | *Schedule* | *Performance* |
|---|---|---|
| $70\overline{M}$ | 21 | 950 |
| | 24 | 975 |
| | 27 | 1000 |
| $100\overline{M}$ | 21 | 975 |
| | 24 | 1000 |
| | 27 | 1025 |
| $130\overline{M}$ | 21 | 1000 |
| | 24 | 1025 |
| | 27 | 1050 |

Assuming that a linear combination of these parameters would be representative,[20] this three-way trade-off can be approximated in mathematical form as $1.2X - Y - 10Z \leq 0$. See Figure 5.

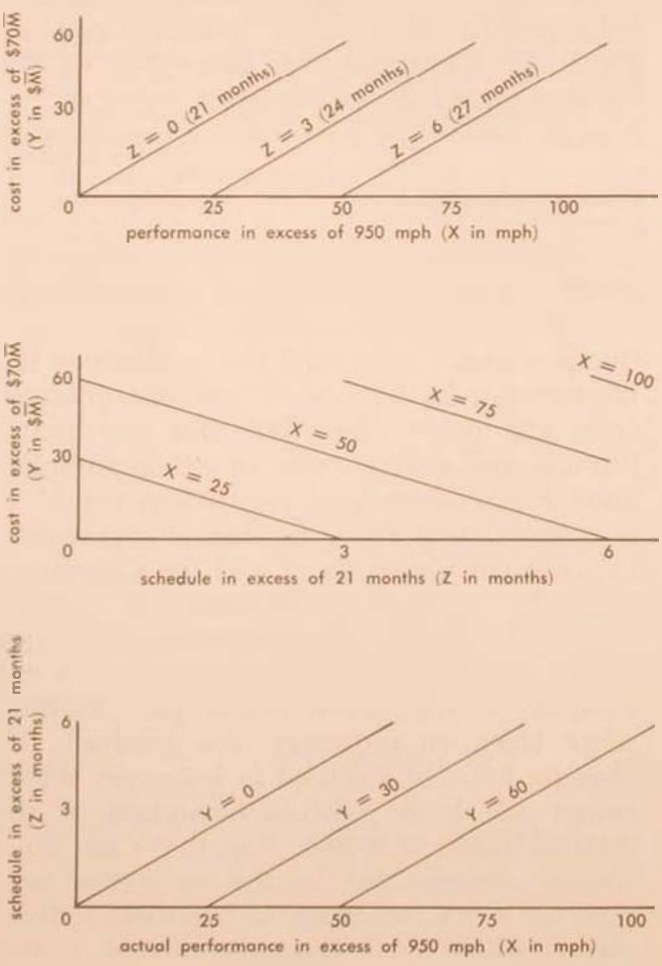
Given this mathematical representation of the "trade-off" function, the optimum policy for a contractor to follow can be determined by mathematical programing techniques. The basic underlying assumption of incentive contracting is that the contractor will plan his activities so as to maximize his fee. That is, he will select that combination of values of X, Y, and Z from all feasible combination alternatives which would provide the maximum fee. For this illustration, the linear program solution yields the following optimal solution:

$X = 50$ mph
$Y = \$0\overline{M}$
$Z = 6$ months

Substituting these values in the formula:

$$F_T = .08X - .10666Y - .26666Z + 7$$
$$F_T = \$9.4\overline{M}$$

*Figure 5. The "trade-off" function*




*The coefficient .08 represents the change in fee for each mile per hour change in performance.

$$\frac{(50\%)\ \$8\overline{M}}{50} = .08$$

The coefficient .10666 represents the change in fee for each million-dollar change in cost.

$$\frac{(40\%)\ \$8\overline{M}}{30} = .10666$$

The coefficient .26666 represents the change in fee for each month change in schedule.

$$\frac{(10\%)\ \$8\overline{M}}{3} = .26666$$

The number 7 is a scale factor.

Thus, the highest possible total fee the contractor could attain under this technical "trade-off" condition would not be \$15M as assumed by the Government but only \$9.4M. Further, and of utmost importance, is the fact that in this example the contractor did not behave as desired or expected. Even though performance was emphasized by structuring the incentive fee 50% to performance, 40% to cost, and 10% to schedule, the technical "trade-off" alternatives in combination with these incentive fee percentages made it more advantageous to the contractor to emphasize cost reduction. Note that performance does not exceed target, whereas costs were underrun by \$30M.

It is significant that one of the alternatives available to the contractor was X=75, Y=30, Z=6, which appears to be more in keeping with the 50%, 40%, 10% weighting factors, and was not selected because the associated fee would be only \$8.2M. In other words, when faced with the alternative of increasing performance by 25 mph or reducing cost by \$30M, the contractor was motivated by the fee structure to choose the latter.

### *contract changes*

Last, it is necessary to review another difficult area of contracting even without incentive provisions; i.e., contract changes. Incentive provisions compound the problem as the impact must be determined not only on target costs and profit (fee) but also on sharing formula and ceiling price or maximum-minimum fee. Procurement regulations state, "It is essential that there be explicit agreement between the Government and the Contractor as to the effect on performance of contract changes."[21] Ideally, the negotiation of changes should not allow either party to reprice those elements of the work unchanged. Further, when incentive provisions are involved, the changes must be handled in a manner which causes the least possible disruption of the original incentive matrix. E.g., in the last illustration, assume that as the contractor progressed, it was necessary to negotiate a \$10M change which resulted in a negotiated + \$1M change to the fee (10%). The new target cost is now \$110M and the new target fee is \$8M (7.3%). With regard to the incentive provisions, the adjustments are commonly made in either of two ways:

a. Maintain the dollar relationships as expressed in the original contract. Maximum and minimum fees are adjusted upward by the same dollar amount that was added to the target fee (\$1M). Thus, the form of the share line remains constant (shifted to the right \$10M and up \$1M), the fee swing is still ±\$8M, the range of incentive effectiveness is still ±\$20M, and the dollar amount of reward/penalty for similar overruns and underruns from the new target cost is the same. Note this technique does not recognize any uncertainty associated with the change (except as negotiated in the new fee increment). (The original contract recognized ±\$20M uncertainty, whereas the new arrangement presumes 100 per cent confidence in the cost associated with the change except as the agreed-to weighting might affect them.)

b. Maintain percentage relationships of the original contract and disregard the dollar relationships. Using this technique the new target cost and fee would be adjusted as in a, above, but the new maximum fee would be adjusted to \$16.5M (15%) rather than to \$16M and minimum fee to −\$1.1M rather than to 0. The contractor fee swing becomes +\$8.5M and −\$9.1M (rather than staying ±\$8M). This illustrates that, by incorporating the change so as to maintain percentage relationships, you increase the range of incentive effectiveness which not only recognizes uncertainty associated with the change but also increases the uncertainty range of the old or unchanged portion of the contract. Unfortunately, it accomplishes this in an arbitrary and not necessarily rational manner.

While neither technique is completely satisfactory, the constant dollar approach has some apparent advantage because it is easier to administer and because it merely shifts rather than changes the original share pattern. The constant percentage technique on the other hand changes the original incentive pattern for all incentive elements and the trade-off ratios regardless of whether or not they were actually affected by the change in work.[22]

The concept and objectives of incentive contracting appear to have merit. It would seem most profitable for users of such contracts to do considerably more research regarding what these writers have identified as the technical "trade-off" function as well as how to administer contract changes effectively and accurately.

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**Notes**

1. J. O. Wright, Chairman of the Board, Thompson Ramo Wooldridge, Inc., in a speech at a cost-reduction symposium sponsored jointly by the National Securities Industrial Association and the Department of Defense in June 1961.

2. Cost reimbursement contracts with percentage-of-cost fees (CPPC), first used during World War II, gave contractors an incentive to increase costs and hence fees. The cost-plus-fixed-fee contract, successor to the now-prohibited CPPC contract, does not provide incentive to the contractor to operate more efficiently.

3. The War Department included a performance incentive feature in the 1907 Wright brothers' contract. They were to be rewarded by a 10 per cent bonus for each mile per hour the plane would perform in excess of 40 miles per hour.

4. Arthur D. Little, Inc., as quoted by I. Kalikow, Federal Government accountant, in "Defense Incentive Contracting," *The Federal Accountant*, March 1963, p. 68.

5. Department of Defense, Assistant Secretary of Defense (I&L), "Advanced Incentive Work Shop," 1963, Part I, p. 1.

6. The Defense Department, according to a recent article (Associated Press in *Dayton Daily News*, 31 December 1963), cited statistics showing that the trend of defense contract profit margins (on costs) is downward, in 1956 the average profit being 6.3%, in 1962 3.1%.

7. "Rickover Assails Undue Profits," *Dayton Daily News*, 30 December 1963.

8. See Armed Services Procurement Regulation, Section III, paragraph 404.4a(1), p. 328; paragraph 405.4(a), p. 334 (and paragraph 405.4(c), *Limitations*, for applicability of maximum fee limitations to CPIF contracts); and paragraph 3, 405.5c(2), p. 336, respectively. Regarding restrictions on fee, these can, in some instances, rule out any effective incentive being incorporated, and thus, these writers believe, the Government should seriously study the feasibility of relaxing such restrictions.

9. Department of Defense, Assistant Secretary of Defense (I&L), "Advanced Incentive Work Shop," 1963, Part I, p. 17.

10. *Ibid.*, p. 16.

11. For example, for one negotiation, an airframe manufacturer submitted 45 pages on profits.

12. See Armed Services Procurement Regulation, Section III, paragraph 808.4, for the weighted ranges by individual profit factor; e.g., direct material purchases have a range of 1 to 5% whereas engineering labor has a range of 9 to 15%. Again, this effort may be too conservative to achieve the desired result.

13. See DOD Directive 5126.38, 1 Aug 1963; DOD Instruction 7700.4, 8 Aug 1963; and DOD "Guide to the Evaluation of the Performance of Major Procurement Contractors," 26 July 1963.

14. See Armed Services Procurement Regulation, Section III, paragraph 405.4(b), dated 6 March 1964.

15. Department of Defense, Assistant Secretary of Defense (I&L), "Advanced Incentive Contract Workshop," Part V, p. 49.

16. Reference the current DOD Directive 3200.9, 26 Feb 1964, and Air Force emphasis on the definition phase (e.g., AFR 375 series) for constructive efforts in this area.

17. Early delivery might well be desirable when the item is independent of other systems or is on the critical path for development of an overall system.

18. Within context of overall objectives of the Government so that the incentive matrix developed causes the contractor to make decisions and perform in support of these objectives. Reference subsequent discussions concerning this problem.

19. Performance could have more than one element set up for incentive. Recognize, however, that the more elements involved the more complex the matrix and contract administration.

20. The actual form of the "trade-off" function is most certainly nonlinear; however, over a limited range of values, a linear representation may be a reasonable approximation. For further discussion, see Chapter 9 of *The Acquisition Process* by Peck and Scherer.

21. See ASPR 3-407.2(a)(4).

22. Headquarters USAF, in a letter, "DOD Incentive Contracting Guide, AFP 70-1-5," dated 8 January 1956, states: ". . . It should be recognized that either method can be used and the determination as to which is preferred will depend on the specific procurement situation. Each has advantages and disadvantages. . . ."

# ECONOMIC ASPECTS OF MILITARY ASSISTANCE

Captain Douglas N. Jones

While it is generally not good practice to begin an article on a negative note, two disclaimers are in order: first, that in suggesting some of the positive economic aspects of military assistance this paper should not be viewed as an apology for military aid. To the economist the high "opportunity cost" of such assistance is well recognized and admitted to if the comparison is with the food, clothing, and shelter demands of a country and its population. The point here is that it is equally erroneous to think of all military assistance as "down the drain" in an economic sense. Second, even within the current development of the recipient countries there is danger of attributing too much to the military assistance program where coincident progress is found. Again the plea is that in its economic aspects the program should be viewed as one significant form of annual aid. Specifically stated, our question is, "How far does foreign economic aid understate total economic aid through the spillover economic effects of military aid?"

Consideration will be given to objectives and alternatives to military assistance, some history and present status of the program, direction and magnitude, and issues and implications.

## Objectives and Alternatives

Military assistance is, of course, one of the four basic components of the Foreign Assistance Program. More obviously economic in aspect are the sister programs: Supporting Assistance, which consists of raw materials, commodities, machinery, and tools, plus financial assistance to support the defense production of our allies; Technical Assistance, which consists primarily of technical cooperation with developing countries; and Development Loan Fund, designed to strengthen friendly foreign countries by encouraging the development of their economies. As stated in the Foreign Assistance Act of 1961 as amended, it is the purpose of this part (of the act) ". . . to authorize measures in the common defense against internal and external aggression, including the furnishing of military assistance upon request to friendly countries and international organizations."[1] This involves furnishing eligible military forces with the end items, spare parts, and peculiar supporting, training, and other equipment that will enable them to resist external aggression and maintain internal security.

The concept of a strength around the periphery of the Communist world created and maintained by joining the capabilities of ourselves and our allies is central to the whole security program. We spend $51 billion annually on our military establishment and have averaged about $1.4 billion on the Military Assistance Program (MAP) during the past ten years. For this latter expenditure we gain men, equipment, and bases from the recipient country. These are estimated as 4 million men in ground forces, 1900 combat naval vessels, and some 8000 operational aircraft.[2] And since we could not or would not likely supply all these ourselves and deploy them around the world, the alternative to MAP would be some form of the "Fortress America" concept.

## History and Present Status

The current program can be traced back to the transfer of 50 destroyers to Great Britain in 1940 and the Lend-Lease Act in 1941.[3] Large sums are not new to such programs. By the end of World War II the dollar value of lend-lease deliveries had exceeded $48 billion; between 1947 and 1950 Congress had allotted more than $645 million for Greek-Turkish aid; the Marshall Plan, which had significant military aid provisions, amounted to $12.5 billion from 1948 to 1951.[4] Added to this should be expenditures for the period on various multilateral and bilateral arrangements, e.g., NATO and the Berlin Blockade.

Still at the heart of the present program are the three key provisions of the Mutual Defense Act of 1949—grant aid, direct transfers, and technical help. The Mutual Security Act of 1951, understandably emphasizing the military aid over the economic, consolidated all the various aid ventures from the several Government agencies into a single Mutual Security Program and placed it under the Department of State. Then in 1954 the act was amended to divide the economic and military portions of foreign aid between the Departments of State and Defense. Finally, the Foreign Assistance Act of 1961, as amended in 1962 and 1963, replaced all others. Key provisions of these acts (together with an executive order and administrative evolution) that make for better control but more flexibility are (1) military assistance may be provided not only by loan, grant, or sale but also by lease, exchange, or any other means; (2) the Joint Chiefs of Staff are charged with continuous review in terms of global strategy and security; (3) Military Assistance Advisory Groups (MAAG) are answerable to unified commands of the areas as the established channel to DOD; (4) military assistance plans are 5-year time-phased and reviewed annually; and (5) the Agency for International Development is made responsible for coordinating MAP with both economic assistance and foreign policy.[5]

The questions of whether or not there has in fact been a shift from military to economic aid, the regional appropriateness of each, and the meaningfulness of the distinction are treated in the following section.

## Direction and Magnitude

Since World War II the United States has extended about $100 billion in foreign assistance to over 100 countries and regional groups. Of this amount, the figures are over two to one on the side of economic aid. Even in areas where military operations have erupted dramatically to public notice and one might expect military expenditures to have predominated, this has many times not been the case. And while it seems a good rule of thumb to say that our emphasis should shift as the threat and our views of the threat shift, this is not to say that the two are mutually exclusive. Economic aid "versus" military aid is largely a false issue—rather they generally support one another. First, even in cases where economic development is judged to be a key objective, it is not always clear that a given amount of economic aid is more conducive to economic growth than an equivalent amount of military aid. This is especially so for some Latin-American countries, for example, where assistance for internal security is predicated on the grounds that the military has an essential role as a stabilizing influence in these countries. Second, it can be argued that in results—if not in labels—the two are almost interchangeable in that military aid will release resources and funds of the recipient country for diversion into other uses, and vice versa. Finally, and our chief concern in this paper, direct spillover effects from military assistance—like infrastructure expenditures and civic-action programs, like road and harbor construction, communications and sanitation facilities—clearly have significant economic aspects.

The hypothesis that there is some kind of inverse relationship between military and economic aid is dismissed by the Draper Report through its findings in 24 countries studied where the economic growth rate was less than 2 per cent.[6] Ten of these countries showed a high rate of military investment, two a moderate rate, seven scarcely any military growth, and five a zero or a negative military growth rate. Thus only 10 of the 24 countries lend any support to the argument at all. Further it must be remembered that economic growth itself does not necessarily preclude Communist incursions—witness the strength of the parties in France, Italy, and Cuba.

At another point the Draper Report concludes that the matter of emphasis between economic and military aid should be dictated by whether strategy appropriate to the country involved is long-run or short-run in nature, whether of the cold-war strategy or hot-war variety. Thus if the threat is primarily external, as in the case of countries on the Soviet periphery, military assistance would predominate, while economic aid may be more appropriate to countries like the emerging African nations which are remote from immediate military danger but prone to internal threat.[7]

However this may be, it is clear that the Military Assistance Program itself has been quite responsive in magnitude and direction to the thermometer of international tensions. Not surprisingly, the bulk of U.S. military aid has gone to the world's trouble spots of the postwar era. The most casual newspaper reader would probably arrange the order about as the evidence indicates in the accompanying table. Note that over the period about one half our aid has gone to Europe, one third to the Far East, one sixth to the Near East and South Asia, and tiny amounts to Africa and Latin America. Note too that even in the short period presented (1961–64) the trends are suggested as Europe stabilizes and picks up more of its own tab while South Asia, the Far East, and Latin America increasingly heat up.

## Military Assistance Program Comparison by Region

| | FY 1964* | FY 1963 | FY 1962 | FY 1961 |
|---|---|---|---|---|
| Europe | 16% | 15% | 20% | 28% |
| Africa | 2 | 2 | 2 | 1 |
| Near East and South Asia | 31 | 28 | 22 | 23 |
| Far East | 44 | 44 | 46 | 41 |
| Latin America | 6 | 5 | 4 | 3 |
| Nonregional | 1 | 6 | 5 | 4 |

*(estimated)

Note: Percentages may not total 100 because of rounding.

Source: Proposed Mutual Defense and Assistance Programs, FY 1965, Summary Presentation to the Congress, Government Printing Office, 1964, p. 206.

Military assistance reached a peak of $5.7 billion at the time of the Korean War and the NATO buildup. The request for $1.0 billion for FY 1965 is close to the average appropriation that has prevailed since FY 1959, i.e., $1.4 billion. The cost of military assistance thus represents approximately 2 per cent of the amount required annually to support the U.S. military establishment.

Finally it should be pointed out that for many countries their defense effort is consequential relative to their gross national product (GNP) and large compared to other common measures of economic magnitudes. A 1961 RAND Corporation study of seven countries over the 1958–59 period showed the median proportion between defense and GNP to be 5.2 per cent; between defense and gross investment, 34.3 per cent; between defense and Government expenditure, 53.3 per cent; and between defense and Government investment 81.7 per cent.[8] In economic terms the question is posed, How can military assistance, and the structure of defense forces and budgets in underdeveloped countries, be modified so as to yield approximately equivalent military effectiveness and yet generate substantially improved economic and political effects?

The study sets out the principle that where the primary criterion—in this case, military effectiveness—does not indicate obvious preference for a particular alternative program, the choice should be made on secondary criteria. This might be a consideration of economic performance through a comparison of the effects of alternative military programs on the operating costs of the defense establishment, on public capital formation, and on the generation of skills in the recipient country. Here one would choose the program with the best ancillary economic developmental effects on the basis of the *differential* opportunities.

In the concluding section I shall take up some of the issues that are still loose in the Military Assistance Program and cite some of their implications.

## Issues and Implications

Finding the appropriate focus of attention along the spectrum of resistance to external and internal threats presents the policymaker with a serious dilemma. If too many resources are devoted to countering the external threat, the recipient country becomes vulnerable to internal instability, e.g., Korea. If too much is devoted to the internal threat at the neglect of the external, adventurous grabs may be invited, e.g., India. And if the resources of resistance are spread too thin in combination, exploitation of the vulnerabilities can be expected, e.g., Laos. Furthermore, internal stability and order may come at considerable cost, as is sometimes alleged in the case of Latin America.

Establishing helpful standards of judgment for deciding what countries should receive military aid (and how much) is a second difficult task. Some argue for an annual, ad hoc, case-by-case analysis of the distribution of the cost burden, while others contend that the uncertainty of assistance inherent in such an approach is destructive to the posture of the recipient country. Presently annual reviews of longer-range aid plans, with significant downward modifications largely limited to the end years, seem to satisfy the latter objection.

If it is felt that military assistance is not particularly well suited to meeting erupting immediate crises, it is all the more clear that any program must be carefully linked with the overall pattern of U.S. strategic policy for that country.

Third, while there is general agreement that economic assistance must accompany and be integrated with military aid (especially in the case of underdeveloped countries), the tests for military *participation* in economic development are not so clear. Three suggested guidelines might be where participation (1) does not unduly detract from the military task, (2) is not contrary to the long-run development of institutions of popular preference, and (3) is clearly in the public's interest, as opposed to that of any special-interest groups. Examples of productive participation of local military people in civic-action programs are myriad. These have typically come in the areas of agriculture, industry and mining, transportation and communications, sanitation and housing, labor skills, and public administration. They include crop dusting by the Air Force in El Salvador and veterinary service by the Army in Argentina.

The technical training of foreign military personnel is frequently cited as a major aspect of the Military Assistance Program. Approximately 175,000 foreign nationals have been trained in the U.S. under the program, and about 60,000 more have been trained overseas at U.S. installations.[9] Still others have been trained in their own countries by U.S. teams. Besides their hoped-for political role in stabilizing internal upheavals, their spillover skills and educational and technical competence can be viewed as a substantial input to the human capital of their countries.

Finally, passing mention should be made of the relation of MAP to the balance-of-payments problems currently experienced. Testifying on the Foreign Assistance Act of 1962, General Lyman Lemnitzer, Chairman of the Joints Chiefs of Staff, said, "There is a collateral benefit of our Military Assistance Program which is not generally appreciated. Our Military Assistance Program does not result in a flow of gold from the U.S. The contrary is true."[10] The \$335 million of MAP funds spent outside the U.S. in 1962 was offset by \$800 million received that same year from the sale of military equipment under the program. The receipts for 1963 were reported as \$600 million. Of course the shifts from foreign buying to U.S. buying and from grants to sales (credits) were the key changes that reduced the domestic trade implications of the Military Assistance Program.

It is likely that the above issues, and others, will continue to be debated as with all Governmental programs where the costs are easy to determine and the returns are not. It is equally likely that the Military Assistance Program will continue at about its present size (not to say direction), barring either a dramatic change in the long-term international climate or a profound shift in U.S. defense strategy.

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Notes

1. *Foreign Assistance Act of 1961*, S. 1983, Public Law 87-195, 87th Congress, 4 September 1961, Part II, Chapter 1, p. 10.

2. *Foreign Assistance Act of 1963*, S. 1276, Hearings before the Committee on Foreign Relations, U.S. Senate, 88th, 1st, June-July 1963, p. 181. This does not of course imply any direct involvement of these forces with the U.S., except to the degree that they are firmly committed with us in bilateral or multilateral defense agreements.

3. The historian would likely suggest earlier spillovers of military/economic development in the U.S., e.g., West Point and the Corps of Engineers, exploration of the West, Navy geodetic surveys, air charting and graphic services, flood control, canals, and railroad activities.

4. *Military Assistance Program: Information and Guidance* (5th ed.; Washington, D.C.: Headquarters USAF, January 1960), pp. 1-4.

5. *Military Assistance Program: Information and Guidance* (6th ed.; Washington, D.C.: Headquarters USAF, 1962), pp. 8-16.

6. *Supplement to the Composite Report of the President's Committee to Study the United States Military Assistance Program* (Draper Report), II (Washington, D.C.: Government Printing Office, 1959), Annex C, p. 62.

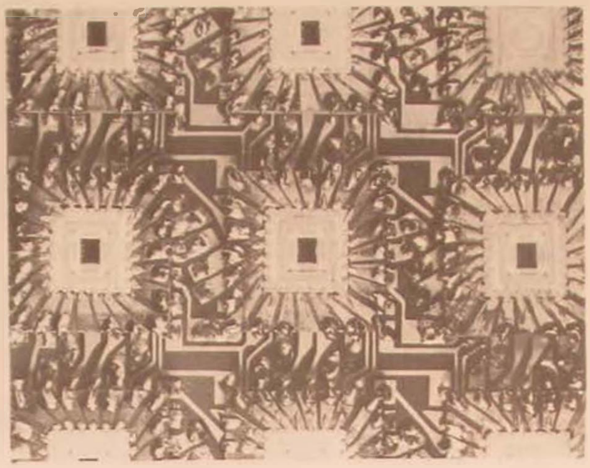
7. *Ibid.*, pp. 36-37. It is recognized of course, as mentioned, that "stability aid" may be required in the form of military assistance even in nonperipheral countries as an element of order and authority. Also the whole idea of counterinsurgency and its evolving requirements may severely upset this neat distinction.

8. C. Wolf, *Defense and Development in Less Developed Countries* (California: RAND P 2291-1, 1961), p. 1. The countries studied were Burma, India, Indonesia, Korea, Pakistan, Philippines, and Viet Nam.

9. *Foreign Assistance Act of 1963*, p. 12.

10. *Foreign Assistance Act of 1962*, pp. 66-67. See also Secretary McNamara's testimony, *Foreign Assistance Act of 1963*, pp. 181-82.

# The Science Frontier



## RESEARCH IN COMPUTER SCIENCES

Dr. Hans H. Zschirnt

EVIDENCE of the explosive expansion of data-processing techniques is all about us. Our pay checks and mortgage statements, our driver's licenses and magazine subscription forms are growing more and more alike in appearance—rectangular cards with one corner missing and garnished with mysterious, likewise rectangular, holes. These cards are destined to tell some machine something about us that we are not always sure we want the machine (or anybody, for that matter) to know. That these holes have a particular tendency to cluster in that part of the card where it says, "Sign here," may account in part for some popular resentment against automatic data processing.

All operations that require large-scale record keeping and manipulation, such as banking, census, tax, libraries, transport scheduling and reservations, and other logistics operations, are rapidly on their way to becoming fully automated. Added to this are control functions such as space operations, process control in manufacturing, surveillance and control of traffic in the air and on the ground. The result is an almost endless list of applications, actual and potential, of data processing, not to mention the vast amounts of technical and scientific computation that require computers of ever increasing capabilities.

The armed forces, and particularly the Air Force, are making extensive use of military variations of many of the applications of automated data processing mentioned so far. But they add to them their own specifically military requirements. It would lead too far to examine these special requirements in detail, but some general properties of the military environment are evident. For example, there is the sheer size of the operation to be controlled (as in global logistics operations) and the need for processing in real time, i.e., the need for the data-processing operation to keep pace with the unfolding processes that it evaluates or controls.

Furthermore, when an information-processing system is conceived and designed, it is often not possible to predict completely the data environment in which it will have to operate. That may greatly depend on some future strategic situation. We may also not be able to describe completely the specific goals of the system in actual use. This calls for a high degree of operational flexibility. In addition, many military systems operate in the presence of inevitable uncertainty. We hope they will be capable of helping us make the best of that situation. Further, many military systems are intimate composites of decision-making and operating people and evaluating, computing, digesting, displaying, and decision-aiding machinery. The presence of the man/machine interface—as well as the vital importance of its smooth functioning—is one of the most crucial aspects of information-processing systems in the military domain.

There are also special physical requirements on the equipment, such as transportability, need for extreme miniaturization or radiation- or heat-resistance.

Research in computer sciences, or, better, information sciences, has thus become a vital part of our scientific picture. It is also evident that the armed forces have a considerable stake of their own in this research.

In this article we shall examine, without any claim to completeness, some of the more pressing problems that presently exist in information sciences. In doing so, we shall mostly use a rather utilitarian approach, such as asking, "What do we have to do about information-processing systems so that the computers will do the most for us?" This attitude will not save us from some thought transcending the confines of computer technology. To give a sensible answer, we have to examine the entire complex of computers, people, the environment they live in, and the nature and mechanisms of their interactions—in other words, a goodly portion of the realm of cybernetics. Nevertheless we shall take a somewhat restricted view based on some applicational viewpoint. But in the background lurks uncertainty about the fundamentals.

### *some properties of digital computers*

Common to all automatic information-processing systems is the fact that they are centered about a digital computer. All digital computers in operation today are direct-line descendants of the machines envisioned by Turing in the 1930's and von Neumann in the 1940's. They are sequential in operation, have a stored program, and possess memory.

The information on which the computer operates is encoded in binary digital form as sequences of zeros and ones, most frequently signified by the presence or absence of an electric voltage. This coded information is usually arranged in groups of a fixed number of digits, often called words, and sometimes in subgroups corresponding to characters. Let us remember that four binary digits (bits) are necessary to encode a decimal digit and five to seven, depending on the size of the alphabet, to encode alphanumeric characters.

Other binary sequences, following the same word organization, are characterized as "instructions," i.e., they are interpreted by the machine as steering signals which cause certain discrete operations to be performed on the data whose location in memory is indicated in the instruction word. Thus the instruction code is the internal "language" of the machine. The sequence of instructions, describing the complete computing process desired, is called the program. Both program and data, externally furnished or internally generated and needed for future reference, are stored in the memory in word locations bearing numbers (addresses) and can be retrieved, changed, transferred, or discarded when called for in an instruction. Finally, there is input gear for the introduction of data, programs, and ad hoc operating instructions, and there is output gear for the communication of results to the user.

The speed of internal processing is one of the striking features of digital machines. Two millionths of a second per instruction is rather common in modern machines, and further increases in speed by orders of magnitude are just over the horizon. Desirable as speed may be—and there are important needs for further speed increases—it appears, however, that speed is not our biggest problem at the moment and certainly not for the more distant future.

This broad-brush sketch of a typical computer suggests a number of properties which have given rise to important problems for research in information sciences, some of recent emergence and some of long standing.

Because a stored program can be altered at will or replaced by a completely different sequence of instructions, the machine can perform an infinite variety of tasks without change of its physical configuration. This lends to digital computers a universality unparalleled in other physical tools. The internal communications of the machine occur in the abstracted form of binary symbols, regardless of their nature as data, instructions, addresses, or internal housekeeping signals. The latter three can therefore be operated on, if desired, in the same manner as the data. Thus, the machine can modify its own program and automatically rearrange its operational structure; it is, in short, capable of manipulating abstract symbols in any way that can be described in terms of mathematical logic. From this, the term "logic machine" derives its justification; a whole branch of mathematics, automata theory, concerns itself with the properties and behavior of generalized computers and uses for its mathematical tools concepts and methods touching closely, on occasion, upon the very fundamentals of mathematics.

Thus, our machine is capable of much more than just rapidly and accurately executing numerical calculations or keeping books on all sorts of events involving large amounts of data. Its symbol-manipulating capability enables us to write programs that generate other programs (a capability used in compilers, which we shall discuss later) and to modify programs or parameters conditional on past results. If such modifications lead to an improvement in performance, this might be construed as a certain rudimentary ability of the machine to "learn." Since logic operations in the machine also include operations of comparison and merger of similar symbols according to certain criteria of similarity, one might infer a basic capability of forming concepts, "recognizing," and making decisions—all aspects of behavior akin to human intelligence and implying the great potential usefulness of machines as extensions, "amplifiers," and helpmates of our own mental processes.

On the negative side of the balance, there is the fact that as logic mechanisms, machines operate in a rigidly deterministic manner in the sense that each state of the machine is completely determined by the sequence of previous states and the latest input. (The "state" of a machine is the ensemble of the values of all its internal variables, i.e., the contents of its memories plus complete information as to which of its internal switching devices that are the carriers of the logic manipulations are "on" or "off" at the moment.) In a machine that is expected to perform a useful and describable task, this sequence of states corresponds to the decomposition of the task into machine actions or, in other words, constitutes the description of the task in terms of machine language. Nothing in this sequence can be left to chance. In particular, there must not be any ambiguity at any given moment as to which way in the universe of states the machine will travel next. This is true whether the problem is explicitly programed in the machine or whether the machine is caused to generate its own procedures by being programed in terms of "procedures to produce procedures," etc.

In the ultimate sense, the dictum that "you only get out what you put in" holds true. Even if the behavior of a machine* as observed at its output seems to be the result of considerable mental activity of its own, it is always retraceable to the preconceived layout of the machine and can thus be explained, in principle at least, in terms of straightforward switching theory. There are, contrary to popular belief (and, I am afraid, to the subconscious belief of some of the *cognoscenti*), no miracles in this business.

It is evident, however, that the correspondence between a problem as we see it in terms of our human frame of reference and the way it presents itself in machine terms is extremely tenuous. The user needs an interpreter to converse with this type of machine. Thus has arisen the priesthood of programmers and analysts and, for their benefit, the proliferation of intermediate languages to serve as buffers between human means of communication and the idiom of the machines. If machines are really intended to be extensions of our mental capabilities, the narrowing—or better, bridging—of this gap is a necessity that has become universally recognized.

A second point is that, for all practical purposes, we have high expectations of the infinite number of tasks that machines can do equally well or better than humans. Many current uses of computers give a hint as to what is possible. On the

*By "machine" we mean either the machine as a physical structure or a machine plus its program. One machine executing two different programs may thus be considered, for the purpose of this article, as two machines.

other hand, disagreement is widespread on what the limitations of machine performance are. Opinions, often supported by vigorous argument, range from “Just another appliance” to “Fifty years from now computers will have a symposium on ‘Can people think?’ ” There is ample reason to assume that the truth is intermediate between the two extremes. But the border between the proper and effective use of computers and the efficient and human use of humans is disputable. Not only are we uncertain about the limits of capabilities of future computers but we are also not too sure about the basic strengths and weaknesses of humans regarding data-processing tasks in the broadest sense.

No matter what the division of assignments between man and machine may be, there is inevitably an interface where easy and efficient communication between the two has to occur in order to make Man-Computer Symbiosis (Licklider) happy and productive. A major portion of present computer research is therefore concerned with man/machine communications. Considering the present state of computer technology and use and how it came into being, one might say that much of the effort in the last decade was, first of all, to make computers work, and work well and reliably. The operating speeds and the reliability of computers have increased dramatically, while at the same time problems of maintenance and space and power requirements have been substantially reduced. Solutions—at least preliminary ones—to the problem of man/machine communications in the form of elaborate programing systems and occasional techniques of direct man/machine interactions have been devised and put into use. The existing amount of background research on problems of artificial intelligence is staggering, if measured in terms of printed pages published. Numerous works have been produced on the problems of new and different machine organizations. New electronic techniques have been evolved, particularly in the field of microelectronics and thin-film integrated circuitry, which will make possible machine configurations that were fantastic only five years ago. The emergence of these new techniques contributes a problem—namely, how to use them to the best advantage—and a relief at the same time. Contrary to the past decade and a half, we can be reasonably sure that, if we need and desire a certain operational characteristic in a machine badly enough, it can be realized, although at a price. Thus we are turning more and more to an examination of new concepts.

To a certain degree, our present problems with computers and their use in a man/computer environment are a direct and inevitable consequence of the evolutionary history of computers. As we remarked before, the early creators of logic machines were perfectly conscious that their basic potentialities reach far beyond the immediate purpose of high-speed programed numerical calculation. At the time, however, the shortcomings of the contemporary electronic technique put the burden of designing viable machinery on the electronic engineers. Many computer designs in present use are the result of electronic engineers’ designing machines to the best of their not-inconsiderable knowledge and understanding. The users, mathematicians and programmers, were not always very helpful. The electronic engineers handed the finished product to their customers and said: “Here is the best we can do; program it, and good luck.” As a consequence of this evolution, the overwhelming majority of computers in current use are, basically, tailored to be highly efficient sequential numerical calculators. Only recently more attention is being given to the increasing use in nonnumerical tasks by provision of a larger repertoire of logical instructions and a capability of parallel operations and features to foster a *rapprochement* between user and machine.

Current and future research in the information sciences is therefore likely to be much less dominated by devices and electronic techniques than it was in the past. It is much more vitally concerned with the interrelation of man and machine. Questions that should be in the foreground of our research go like this:

(1) In a man/computer system, how should the work be divided between humans and machines? What can machines do better, and what can humans do better?

(2) How can the communication gap between man and machine be bridged so as to minimize the existing difficulties at the man/machine interface?

(3) Is it necessary to make radical changes in the concept and organization of our computers in order to solve the first two problems, and how can newly emerging electronic techniques be used to help realize those new machines?

I shall elaborate somewhat on these questions.

## Division of Assignments Between Man and Machine

Humans cannot match certain computer capabilities. Any repetitive task of numerical computation, bookkeeping, or data sorting that can be defined in terms of deterministic instruction sequences is definitely within the realm of competence of computers. Included are functions that are normally considered as requiring considerable intelligence, if performed by humans. Bookkeepers and newspaper layout and typesetting people are certainly qualified as highly skilled workers, but computers do just as well, if not better. On the other hand, computers are often inferior even to small children in performing tasks requiring recognition or concept formation, although there are strong indications of a considerable potential for machines in that regard. For this reason a continuous appraisal of the relative capabilities of men and machines is necessary to make the best current use of man/machine systems.

### *some aspects of artificial intelligence*

It is not surprising that the field of artificial intelligence, concerned with automata displaying behavior that in human terms could be described as requiring a certain amount of intelligent thinking, has been very much in the foreground of computer reseach and will certainly continue to be of foremost importance. In fact, recent bibliographies on artificial intelligence—e.g., the excellent annotated bibliography by Marvin Minsky—contain about 500 items written between 1959 and 1961. Another bibliography of somewhat broader scope, covering the years from 1946 to 1959, contains about 4000 items. In part, this prodigious proliferation is misleading as to its real content. The difficulty of defining "intelligence" in a commonly acceptable way is great, and we will not attempt to go into any depth in that respect. Further, since—luckily—authors with varying backgrounds have been fascinated by the subject, it turns out that there are many different ways to say the same thing. Consolidation and unification in this respect, together with some weeding out of the obvious or redundant, will certainly take place in the very near future. Promising signs have been seen lately; the field appears to become less clamorous, less glamorous, and more objectively matter-of-fact.

### *problem solving and games*

Two aspects of machine-implemented "intelligence" (here taken only in the pragmatic sense of a "cooperative attitude on the part of the machine") are of particular interest, namely, the use of machines for problem solving and the machine implementation of cognitive processes. Typical for the problem-solving aspect and of great continuing interest in research over a number of years are such tasks as theorem proving and the playing of games. The purpose here is not so much to create a discipline of "mechanized mathematics" (Wang) or just to prove that machines can be as good chess or checkers players as people, but rather that a generalized solution of such problems would be of staggering significance for problem-solving procedures in strategy, economics, and social sciences that presently overwhelm us humans by their complexity.

The problems mentioned have in common that, in principle, they are amenable to an algorithmic* solution. A barrier that machines run up against with algorithmic processes when performing any but the most trivial tasks is that an exhaustive search of all possible proofs or all possible plays is impossible even for the fastest and largest machine, not to mention the utter lack of elegance of such a brute-force procedure. Instead, we are looking for approaches to successful solutions of problems without exhaustive search of the entire solution space. These approaches, justified mainly by the fact that in similar situations they were successful, are called heuristics. They are extensively used in problem-solving cases using heuristic programing. In such cases, certain heuristics, for their experience-proved usefulness, are built into the program and are selected if the type of problem at hand seems to warrant their use. To determine what the type of the problem is, the machine has to perform an act of classification, to recognize whether the pattern of the problem calls for this or that type of procedure.

At present, by and large, the intelligent selec-

*Algorithm. Some special process of solving a certain type of problem.

```
                    FIRST DEMONSTRATION      Ø1
TO PROVE.  )P)Q@)RP)RQ

COMMANDS.  I), I)

I)
I)

PROOF TO DATE

   *P
       *Q
        ***
        @)RP.)RQ
    )Q..@)RP.)RQ
)P*)Q..@)RP.)RQ


COMMANDS.  Ø48 Ø5

THE CURRENT COMMAND IS NOT WELL-FORMED.

COMMANDS.  Ø4, Ø5

)RP
)RQ

PROOF TO DATE

   *P
       *Q
        ***
        )RQ
        ***
        )RP
        @)RP.)RQ
    )Q..@)RP.)RQ
)F*)Q..@)RP.)RQ


COMMANDS.  I), I)

I)
I)

PROOF COMPLETE  (INTUITIONISTIC)

Ø1      *P
Ø2          *Q
Ø3               *R

Ø4                Q
Ø5            )RQ
Ø6               *R
Ø7                P
Ø8            )RP
Ø9            @)RP.)RQ
1Ø       )Q..@)RP.)RQ
11  )P*)Q..@)RP.)RQ

COMMAND HISTORY.

    I),I).
    )RP,)RQ.
    I),I).
```

*Figure 1. Man/machine cooperation in theorem-proving*

tion of avenues of approach and the machine-aided "playing of hunches" seem mainly a human prerogative, although increasing mechanization of even this function is definitely in the cards. Presently, at least the design and programing of the heuristic procedures to be used are tasks performed by humans, but the selection of the procedure called for by the problem at hand may be mechanized. The next step, of course, is to cause the machine itself to "invent" useful procedures or to improve existing ones according to their past success or failure.

In the area of problem solving, as in other instances of simulation of intelligent behavior by machines, the enthusiasm of the research worker has sometimes tended to get in the way of rapid practical progress. What I am referring to is the attempt to mechanize an entire reasoning process and the complete refusal to accept the available aid of the human operator. I hasten to declare that for *research* purposes, where the objective is to find out how completely a mental process is replicated by a computer, this procedure is, of course, the only possible one. In cases of practical interest, however, the machine alone tends to fail even at moderately complicated tasks. It is here that the collaboration of a man/machine team has the great promise for the near future. Particularly in complex situations—and decision-making systems of military interest are inevitably very complex—this approach has the greatest promise and stands in the foreground of interest.

As a simple example of man/computer cooperation, Figure 1 shows a computer print-out of a theorem-proving task in propositional calculus. Without explaining the problem or going into the details of the notation, we shall only note that a sort of dialogue between machine and operator takes place. After accepting and acknowledging the statement of the problem, the machine "asks" for suggestions on how to proceed ("commands"). Having received those, it goes through a sequence of proof algorithms, then finds that a proof has not been achieved, and requests further suggestions. At this point we see that commands are not accepted unquestioningly. The line "THE CURRENT COMMAND IS NOT WELL-FORMED" is the machine's polite way of saying that the suggestion made was illegal. After correction of that error, the proof then proceeds to a successful finish. Many successful examples of man/computer teamwork are presently under development or in early operation. The applications covered include such diverse subjects as the machine production of technical drawings, the efficient layout of hospitals, and the flow-charting of new computer designs.

### *pattern recognition*

In the center of discussions of artificial intelligence are problems of recognition and classification, often referred to as "pattern recognition." This is rightfully so. The capability to deduce from a limited number of examples of a class of objects their common characteristics, to form a generalized "concept" of this class, and, on the grounds of these concepts, to assign new unknown objects to their proper classes is certainly one of the striking achievements innate to human (and to a certain extent animal) mental activity. Formation of concepts, except where they are built in a priori (in which case our so-called cognitive process would be reduced to a simple deterministic sorting procedure), always implies a certain process of adaptation or self-organization in the machine in question —hence the almost synonymous designation of self-organizing systems, or adaptive machines, or the more anthropomorphic attribution of a capability to learn.

If in this discussion we concentrate on pattern-recognition procedures as prototype of adaptive/cognitive systems, we derive justification from the fact that command control or decision systems or almost any artificially intelligent system of reasonable complexity always has to ask as its primary and crucial question: What does all this mass of input data mean in terms of selection of appropriate action from a limited set of possible courses? Recognizing the "pattern" underlying the input data of the moment is the most important step to a solution. Since the machine procedure operates on input data encoded in machine language and therefore divested of their physical implications, pattern-recognition procedures using any given principle proceed regardless of the data source, be it the automatic reading of print, the interpretation of spoken words or of photographs, or possibly situation assessments pertaining to the field of economics or military strategy. There are, of course, differences in complexity depending on the size of the data base, the number of alternatives of output choice, etc., but no distinctions in principle that depend necessarily on the data source.

The general problem of pattern recognition or automatic classification can, then, be formulated as follows: The events or objects to be classified are described by sets of measurements of distinctive features, frequently called descriptors, of the event. By suitable evaluation of these sets of measurements, it is desired to assign the unknown event to one of a set of categories or classes. To do this, it is necessary to emphasize those features which tend to enhance the dissimilarities between members of different classes and the features most common for members of the same class. At the same time we will have to suppress features which are more or less present to the same degree in all the classes concerned and which therefore do not contribute to the recognition process.

Basically, the development of an effective recognition process is critically dependent on the procedure of assigning weights to measured features. These weights are usually, explicitly or implicitly, derived by examining a statistically significant number of samples of objects belonging to each class and assigning weights to the measured features according to their contribution to efficient classification. This process can be and has been automated. The establishment of sets of weights constitutes a sort of "learning" or "training" phase for the machine not unlike the processes involved in the training of a child or an animal. Let us take a machine intended to read printed, upper-case roman letters. Let us say our measurements to yield distinctive features measure such things as area covered by black ink, length and location of line elements forming the letters, curvature, location and angle of intersection, and the like. By examining a number of samples of letters in different type fonts, we (or the "learning" machine) find that in an upper-case "A" the fact that it is composed of three straight-line elements two of which intersect near the top at an acute angle occurs in most "A's" and should be weighted heavily. But some "A's" are flat at the top. The feature that the "A" is composed of straight lines deserves not too much weight because too many other letters have the same feature. In the "B" the presence of two closed loops, one on top of the other, is of heavy weight. In all cases, the feature that the character is printed black on white deserves zero weight because it is present in all characters. This process of generating efficient sets of weights is quite central to recognition and decision processes.

It can also be described in a number of different ways, which fact accounts in large part for the bulk, diversity, and confusion of the literature on this subject.

Although it may be a little rough going, I will make an attempt to explain how this comes about. In the preceding example we have described the assignment of weights to descriptors as a rather straightforward process of evaluating the statistics of known samples in terms of their distinctive features. Note that we were careful not to state in detail how this statistical evaluation is done; there are numerous ways to skin that cat, and different schemes use different ways.

So far we have talked about features in easily comprehensible ways—in terms of line elements and intersections in the case of printed characters. For those familiar with radar signal detection, let us consider that problem as one in pattern recognition. For a radar receiver, there exist only two classes of events: signals emanating from its own system, and meaningless interference. It has been found that by analyzing the frequency spectrum of the incoming signals and admitting those frequencies that are present in the original transmitted signal to a degree proportional to the degree they were present when transmitted, we achieve an optimal discrimination between signal and interference. This technique is known as "matched filters." Look at it from the pattern-recognition point of view: frequency components = distinctive features; degree of admission of those frequencies = weight. It seems that we can also describe our pattern-recognition scheme as a set of matched feature filters!

Another view of the problem can be had by introducing the rather abstract idea of patterns as vectors in multidimensional space. Let us examine this idea briefly as an example of considerable mathematical abstraction and of the advantages that an abstracted view can have. Assuming that we operate with only two descriptors, we can plot their magnitude along the $x$ and $y$ axes, respectively, of a graph. The point determined by those two coordinates would be a representation of one input object. If our descriptors are chosen appropriately, we would hope that those objects belonging to the same class would be close together on our graph and those belonging to another class conveniently clustered elsewhere. Since the world of mathematics does not restrict us to any specific number of coordinates, we thus plot the location of an input event as a point in a multidimensional "hyperspace," meaning a space having more dimensions than the conventional three that are open to our sensual perception.

Weighting and summing procedures, as in the case of matched filters, result, in this concept, in moving the points in hyperspace around so as to encourage their clustering in a desired way or so as to produce a number representing a "degree of fit" that may tell us to which class to assign the event in question. The matched-filter procedure described earlier is actually, mathematically speaking, nothing but computing the scalar product of the "event vector" and the "weight vector." In performing this abstraction, we have gained much more than a certain convenience of mathematical manipulation. We have divested our inputs of physical significance without taking away any of their information contents. We have, further, reduced the "filtering" or "weighting" concept from a process of selective attenuation or emphasis to a mathematical operation of transformation in hyperspace.

While the physical constraints of the earlier operations tend to confine our thinking to something that is, somehow, physically feasible, the transformation concept leaves us perfectly free to do anything that is allowable under the rules of our chosen mathematics. We can pile transformations upon transformations, make them linear or nonlinear to any degree—ours is the choice and the responsibility. With this generalization, finding a decision procedure becomes a formal process devoid of physical meaning. In the long run, it can be assumed that such general procedures at the decision end of the game will become of high significance, notwithstanding the temptation to make the study of those things a vehicle of theorem-generating mental exercises without great relevance to the central problem.

### *the question of significant features*

So far we have assumed that the descriptors derived from measurements on an event or an object were sufficient and reasonably suitable for the classification process in question. In reality—and this is one of our major problems in producing somewhat sophisticated pattern-recognition or decision systems—this is pitifully not so. The reason is not unawareness of the problem but lack of clues as to what to do. To discover these clues is one of our major objects in information-processing research. In almost all the automatic classification systems that are operating successfully, the descriptors and the measurements leading to them are the results of human experience and some guesswork, or the plain outgrowth of the limit of what the current techniques in electronic measurement can deliver. Fortunately, this is good enough, or nearly so, in many instances. Printed type can be read and square pegs can be distinguished from round holes. In more complicated situations, the discovery of proper descriptors is, maybe, more crucial than the decision procedure used. Our goal, then, must be to discover descriptors that adequately—and, hopefully, optimally—describe the kind of events we are interested in for the purpose of the specific classification we want to perform. In order to develop the descriptors, we have to consider not only the kind of events we expect to deal with but also the goal of our classification process. For example, if we are dealing with solid objects and want to categorize them as "solid" or "hollow," a system of feeler gauges might be a proper measuring device; if, however, our intended classification is by color, the color-blind gauges don't do us any good. Unfortunately, in many of the really interesting problems, present methods of measurement and description may indeed be "color-blind" in some sense and account for failure of the system. The attempt to mechanize a system that observes its own performance and changes its choice of descriptors, and the weight assigned to them accordingly, is an important branch of the research in artificial intelligence.

Let me mention in passing that at the Air Force Cambridge Research Laboratories (AFCRL) an adaptive recognition system is under investigation that generates property filters solely on the grounds of the statistics of events unfolding in time—somehow on the premise "I don't know exactly what I'm looking for but something must be there." Indeed it has had encouraging success in discriminating heartbeats of different people and different spoken words fed to it simultaneously and intermixed. It has achieved separation of heartbeats of person No. 1 and person No. 2, as well as words No. 1 and 2, and so forth, thus illustrating the total independence of the decision process on the data source.

In current successful procedures of recognition, one striking dissimilarity between existing machine procedures and human recognition seems to be apparent. This is the much higher degree of abstraction present in the human process. As an example, let us look at an AFCRL program concerned with the solution, by machine, of aptitude tests based on geometric analogy. Such tests look like Figure 2. The question is: "Configuration *a* is to *b* as *c* is to which of the other configurations?" The answer, in the example, is configuration 4. The machine has consistently performed in these tests somewhat better than the average high-school graduate—so maybe this thing does not really test intelligence. Anyway, the machine goes about the job as follows: It lists in its memory, for each configuration, the coordinates of all points covered by the configuration; combines them into line elements and lists those, including their end points and curvature; determines, locates, and lists intersections and angles and which part of the figure is inside of which other part; and so forth—a tremendous number of minute facts. Then it determines the transformation that has to be performed to convert *a* into *b*, and *c* into each of the other figures, and which of these latter transformations is most similar to the *a*-to-*b* one. It works, but it is certainly not the way humans go about this task. Figure 2 was shown to a number of people in our laboratory, and 80 per cent of them agreed with the intended solution. They were asked to describe the reason for their decision. A typical answer was: "In configuration *a*, a 'clean, solid' outline is inside of something not quite so clean and solid; the same can be said of *c* and 4, respectively." It appears that, in solving the problem, humans tend to use abstract and, at the same time, often quite hazy descriptions. This method enables them to deal with situations not previously encountered more efficiently than the machine and, it seems, more economically (note the striking difference in numbers of descriptors used).

An interesting approach to the development of "learning" machines is to conceive the learning process as a genetic process. This works roughly as follows. Assume, to begin with, that one designs a machine capable of performing a certain task,

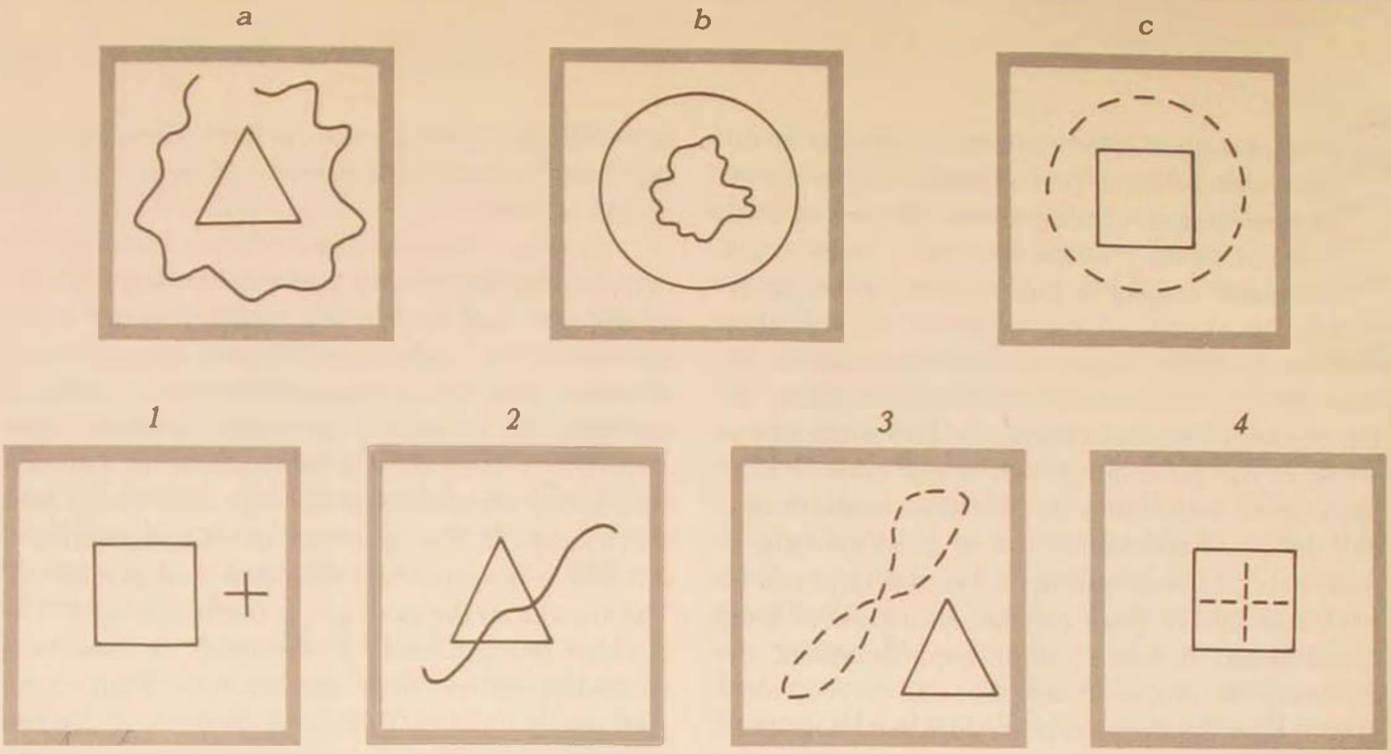



*Figure 2. A geometric analogy problem*

although quite inadequately. Now, we produce a number of replicas of this machine, but each replica has small, random variations from the original. Thus we have obtained a new "generation" of machines with small "mutations." From this generation we pick those that perform better than the original, and we repeat the process of reproduction until we arrive at machines that satisfy our requirement. It has been shown that, in certain fairly simple test cases, significantly improved performance is obtained fairly rapidly.

These examples of procedures and concepts that contribute to a seemingly intelligent behavior of machines, although far from exhaustive, may at least convey some idea of what machines can do and strongly hint at what they may be able to do in the future. It is quite certain that their present main weakness—that they have to be told in too much detail what to do, instead of having the capability to generalize, abstract, and adapt to unknown situations—will be continually improved.

## Capabilities of the Human Partner

What, then, about the capabilities of the second member of the "team," man? The study of psychology, human-engineering, and behavioral sciences in general has indeed accumulated a wealth of material about the strengths and weaknesses of human performance. Added to this are the results of practical experience of human performance under stress—of particular importance in the military environment—and numerous studies especially motivated by military and civilian command and control systems. It seems, however, that possibly our knowledge of the human factor, specifically in the man/machine environment, is less concrete than what we know about machines.

Let us consider an example taken, in simplified form, from a recent study. We consider this situation: The subject is required to cope with an opponent who produces a series of events that the subject sees as "data." The subject is required to make certain judgments from these data, which will presumably lead to some decision on his part. It turns out that human performance may be markedly superior or distressingly inferior to the performance of a suitably programed computer, depending on the kind of judgment required.

We will examine two simple cases. In both cases the opponent has a stack of playing cards from which he puts cards on the table for the subject to see (the "data"). For simplicity's sake, we concern ourselves only with black or red cards—no jokers, no values assigned to the cards. In the first case, the number of red and black cards in the stack is known to the subject. After each drawing the subject is required to estimate the probability of the outcome of that drawing. If the stack contains, at the beginning, half black and half red cards, the estimate would be 50 per cent, regardless of the color of the card drawn. If, later, the number of black cards drawn exceeds the number of red cards drawn, and again a black card emerges, the estimate for the likelihood of that event should be revised downward, and so forth. It turns out that in this game humans perform remarkably well.

The second experiment is slightly different. The opponent has several "strategies" (proportions of black to red cards) at his disposal, from which he can choose one for that particular game. Observing the outcome of successive drawings, the subject has to guess which strategy (distribution) the opponent is most likely to use in that game. Now, given that the probability of the opponent's use of each of his strategies is known, this can be computed from guessing games like those of the first case. Humans perform quite poorly in this game, where the point really is, after each drawing, to assess the impact of the new event on the last previous estimate. Machines do better, while humans seem to be too conservative in changing their opinions in the presence of a new event.

This, to me, is a somewhat disquieting result. After all, a military commander is generally not particularly interested in a numerical value for the likelihood of an observed enemy action but is interested in a fast and dependable assessment of the most likely strategy the enemy is pursuing. The idea that perhaps a machine could do this better than a human is disconcerting. Whether we like it or not, the line of demarcation between the realm of the human and that of the machine is by no means determined; we may be in for some considerable surprises. Remember, in this context, the clever and amusing book on strategies to win at blackjack that has, of late, attracted considerable attention. Its strategies, developed with large amounts of computer assistance, have caused gaming-house operators to modify their rules, which heretofore were perfectly adequate to ensure profitable operation of the game with only human intuition, guesswork, and skill as opponents.

It is, then, not surprising that present research tries very hard to come to a better understanding of the best location of the interface between man and machine. It is also quite obvious that the burden of this determination is not so much on the pure computer scientist as on behavioral scientists' understanding computers and on computer people's caring about human behavior and performance. The results of such research are very likely to have profound effects on future man/computer systems. Assuming, now, that we have determined where man comes in and where the machine's responsibility, as it were, ends, there still remains the problem of making the two interact smoothly at this interface. We have touched on this problem before, but we shall devote the next section to a more detailed examination.

## The Man/Machine Interface

There are two kinds of communication that have to be established between man as user, customer, and, hopefully, master and the machine that aids him in his pursuits: (1) the program that determines the structure, sequencing, and administrative detail of the machine's operation—possibly at considerable levels of abstraction; and (2) the specific ad hoc mechanism of interaction that communicates to the user specific results and the current state of the machine's operation and allows the user to convey specific instructions, data, and operating commands to the machine.

### *programing languages*

We mentioned before that all internal information in the machine is couched in abstract machine code that has no direct relation to the problem the machine is working on. To run a specific problem on a machine, a scientist not thoroughly familiar with computers will have to use the intermediate services of an analyst and a programmer. The user is in effect separated by a great distance from the machine. To shorten this distance, "problem-oriented languages" have been created whose object is to make it possible for the user to state his problem, or, more precisely, specify the desired procedure, to the machine in a form as closely as possible related to the form in which he would state the problem for his own use.

A large number of such languages have come into use, among the best known being FORTRAN

(FORmula TRANslation), ALGOL (ALGebraic Oriented Language), and COBOL (COmmon Business Oriented Language). Problem-oriented languages are machine-independent, unlike assemblers, which are characteristic of their machine type. Programs written in a problem-oriented language must be translated into the internal language of the machine. This is done by compiler programs. Compiling occupies a significant part of the activities of a large-scale machine, often consuming on the order of 30 per cent of the useful machine time. Thus the economic significance of the compiling load is considerable. Nevertheless, programing languages do facilitate our communication with machines and indeed make the programing of large-scale computing systems possible. The advantages of procedure-oriented programing languages are striking. First, they bring the computer program into close relationship to the problem as seen by the user; second, one instruction in the programing language text usually implies a large number of individual computer instructions which are automatically detailed in the compiling process; and, last, the use of a proper programing language automates a number of tedious housekeeping tasks which must be done explicitly when programing in machine code.

For these advantages we pay a price. First, the advantage of close relation between the program language and the problem implies that, to be efficient, the language is pretty much restricted to the problem area for which it was designed. Thus arises the large number of languages that we have today and the need for numerous compilers and translators to make possible their use and the interchange of programs. This process is cumbersome and costly. At the same time the languages that we use to converse with machines and which they use to talk back to us are still far remote from the way we would like to talk, even if we agree to accept considerable restrictions in our freedom of expression. Figure 3 shows a reprint of a program intended to perform quite a human task, namely, bidding at contract bridge. One sees that, although there are numerous hints as to what is going on, this language has to be learned! In fact, some of the major programing language manuals run to hundreds of pages containing vast numbers of rules which have to be followed meticulously.

The goal of present research in programing languages is evident from this list of shortcomings. We would like the language to be more universally applicable, thereby reducing the number of languages used, and closer to natural language. We also need efficient means of translation from various languages into machine codes as well as from one language to the other. In a way, this means trying to have the cake and eat it. An easily translatable language tends to be extremely formal and, thereby, not too similar to human talk. Program languages that come reasonably close to formalized but intelligible English do so at the cost of being restricted to a very narrow area of problems, as seen in our bridge language. Yet adequate solutions, necessarily compromises, have to be found if computers are to play the roles of which they are capable in, say, military command and control systems.

This has led to intensive research in the science of formal languages and their syntax and grammar. Such questions as equivalence of statements in different languages, translatability and relative efficiency, and effective ways of syntactic analysis are very much in the foreground of present

*Figure 3. Computer print-out in problem-oriented language for bidding at contract bridge*

```
bidrcl (/) = bidrcll (/; ptcount (ptsinsuits (/));
          distntuple (/); biddablesuits (/)
bidrcll (/; p: d; b) =
    Al, lessp (p: 12)    preempt (/; ; p; d)
    Bl, lessp (nooflosers (/); 4.5)  greaterp (p; 2
        bid (1; CLUB)
    Cl, balanced (d;/)→
        A2, lessp (p; 17) V greaterp (p; 20)→ bid
            (1; CLUB)
        B2, T → bid (1: NOTRUMP)
    Dl. threesuithand (/)→
        A2, lessp (p; 17)→ bid (2: CLUBS)
        B2, lessp (p: 21)→ bid (2; DIAMONDS)
        C2, T → bid (1; CLUB)
    El, equal (length (b); 1)→
        A2. equal (firstsuit (b); CLUBS) V goodbutn
            greathand (/;p;b) bid (1: lr3csuit (d))
        B2, T→ bid (1; firstsuit (b))
    Fl, equal (secondsuit (b): CLUBS)→
        A2, greaterp (lengthsuitl (b); 4) Λ greater
            (lengthsuitl (b); lengthsuit2 (b))→
            A3, equal (firstsuit (b); DIAMONDS)→ b
                (2; NOTRUMP)
            B3, T → bid (2; firstsuit (b))
        B2, T→bid (1; firstsuit (b))
    Gl, equal (lrshorter (b); DIAMONDS) Λ lessp (p;
        bid (1; firstsuit (b))
    Hl, T→bid (1; lrshorter (b))
```

research and promise significant results. One sees that many of these topics are just as applicable to natural language, and that, from the point of view of ideal communication between man and machine, is as it should be. Language, after all, is the vehicle of our thoughts. The closer we come to making it flow freely from man to machine, the closer we come to the ideal of an integrated man machine team.

### *language-oriented machines*

We noted that fundamental to our need for programing languages and associated translators is the fact that the machine converses internally in a purely machine-oriented language, the machine code. Perhaps our problem is that we try to make machines do things they were not really designed to do. Recalling that, basically, present-day machines have more than anything else the characteristics of a programed arithmetic calculator, one finds that their internal machine language could be considered as a close cousin to an arithmetic-oriented programing language. It should, then, be possible to design a problem-oriented language of as much generality as possible (by incorporating into it many of those characteristics that are common to many of the existing more specialized languages) and then to design a machine that uses this language as its internal means of communication. Obviously such a machine would not need a compiler, since external and internal language are identical.

At least one such language and its machine implementation have been designed, and the machine is presently under construction. Simulation experiments have shown its significant superiority over conventional machines, particularly in non-numerical processing.

### *direct communication*

Direct communication between user and machine usually occurs by means of keyboards, suitable displays, and printing devices turning out results in the form of printed records. In military command and control systems, where real-time interaction between humans and machines is of vital importance, the means of intercommunication are frequently extremely elaborate. They are

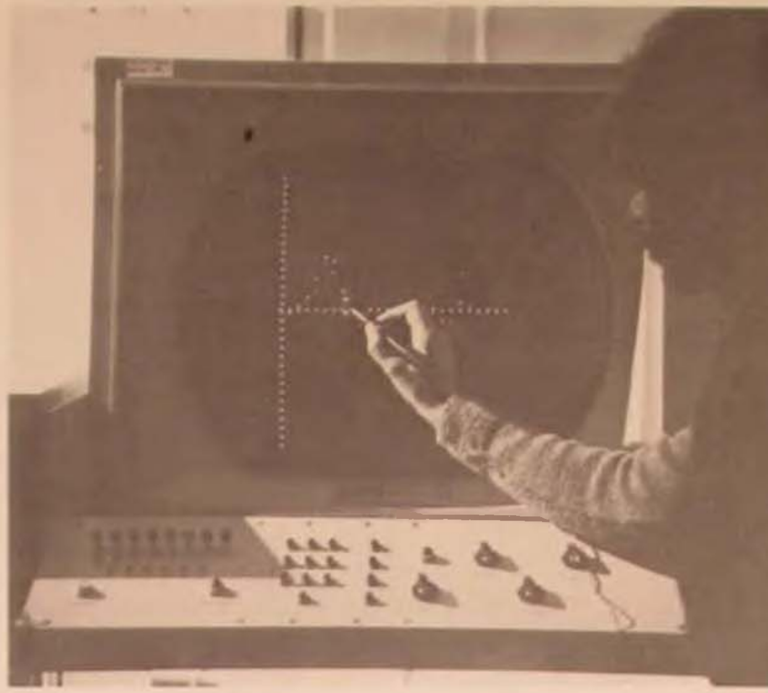


*Figure 4. Direct communication with the computer by cathode-ray tube display and light pen*

the subject of continuing research covering almost all the aspects of computer and human behavior we have discussed so far.

In computation centers, on the other hand, where large-scale production of numerical results is the goal, this interaction is quite restricted. It is, however, recognized that, even in purely computational tasks, the close ad hoc interaction of man and machine can be of extreme value. (Note the example of Figure 1.) For instance, machine programs exist which, given a sketch of some mechanical structure, say, a girder, and the load on it, will produce all the information for the exact construction drawing, including dimensions, stresses on all the members and their connection points, and so forth. Logically, it would be desirable to display this computer-generated drawing to the designer as a drawing, not as a sheet full of printed figures, and to give him a means to sketch in changes and observe the result. This is indeed being done, the means being TV-like cathode-ray tube displays and "light pens" allowing the user to introduce data and instructions into the machine by drawing graphs on the face of the tube. The same procedure proves of great utility in mathematical computations of complex situations where unfolding processes can be observed graphically and controlled by the operator. Figure 4 illustrates such an arrangement.

In many applications, this and related techniques of linking man and machine are attracting increasing attention as one of the most promising ways of teaming the capabilities of the human and the automaton.

There are limitations to this direct cooperation. Technically, there is the disparity of operating speeds. In the time scale of computer operations, the time an operator takes to make up his mind about what to do next is a costly eternity. The monetary value of a minute's running time of a large-scale computer is about $10. This suggests, for economy's sake, the use of relatively small computers or time-sharing of larger installations, where during waiting times the computer does something else, such as running a production program or serving other customers. Meanwhile the individual user retains the impression that he is in control of the machine. Several time-sharing systems of this kind are in experimental operation. In systems with many sharers, things can become a little complicated. Not only must the machine do the work, it also has to allocate time to users, minimize waiting times, and—last but not least—make out the bills for services rendered. Thus a sizable part of its capacity may be consumed by administrative chores.

## New Concepts—New Machines

### *the influence of new applications*

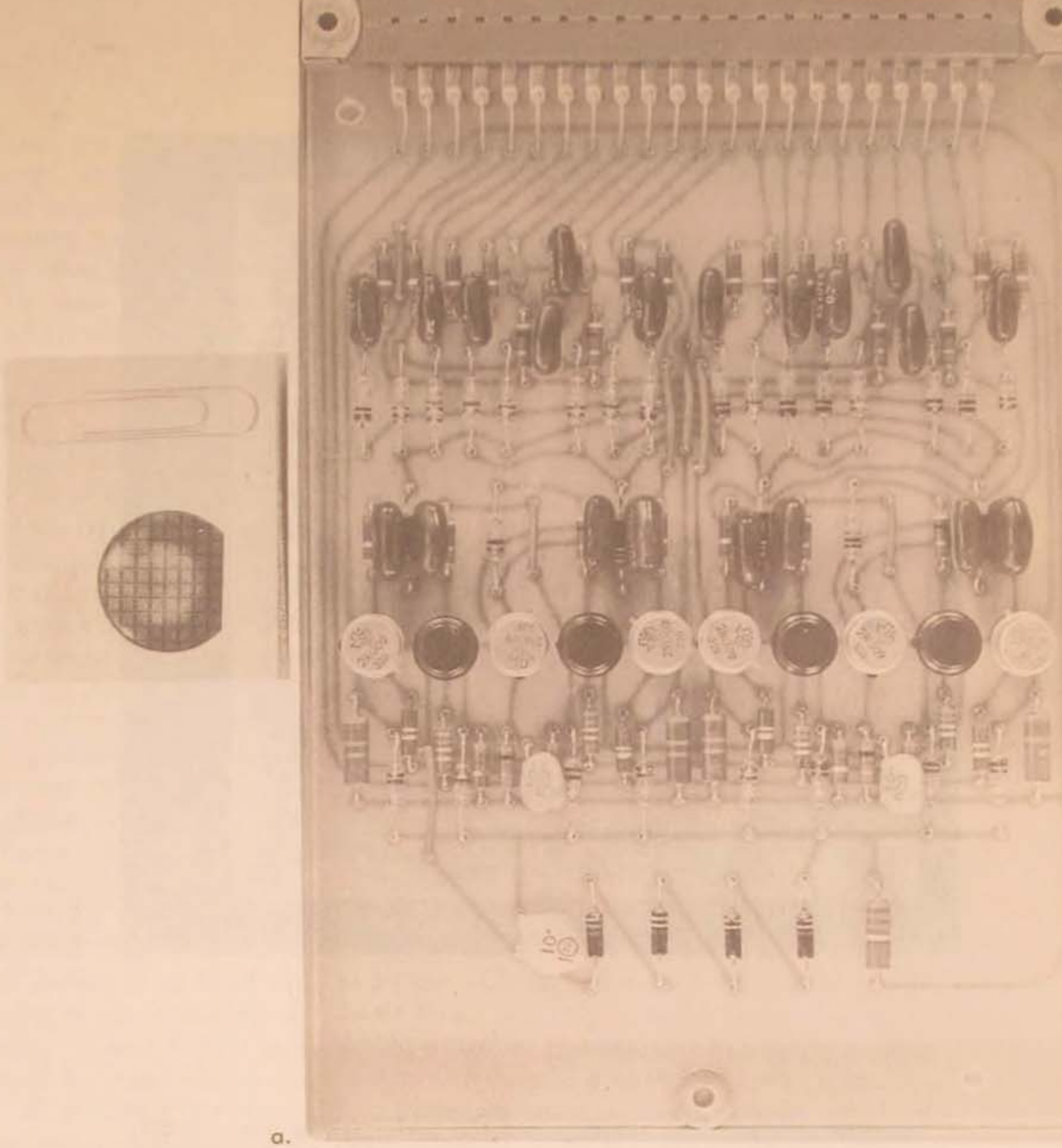
In our discussion so far, we may have—unintentionally—created the impression that our current computers are more or less set in concrete and that all we can do is to make the best possible use of them the way they are. Nothing can be further from the truth. Two interacting factors continually force new developments in the internal concept as well as the physical embodiment of new machines.

One is that new machine applications demand properties of our machines that are not present in conventional computers. For instance, we notice that in many applications already discussed we have to perform fairly simple operations on very large amounts of data. Very frequently, as in the case of pattern-recognition schemes, these operations are individually independent of each other and could very well be performed simultaneously. This is also true for many computational tasks. This leads to the concept of all sorts of parallel processors which in their practical realization run the gamut from relatively straightforward configurations of multiple arithmetic units to assemblies of full-size computers that can operate independently. These machines converse with each other and merge their operations where appropriate by way of common memories and under control of a central unit that can be visualized as a combination of supervisor and traffic cop.

In other cases the restrictions imposed by the rigid organization of existing computers are in the center of attention. Machines are contemplated that are capable, to a certain extent, of varying their internal organization as required by the problem at hand. The language-oriented computer concept described earlier is another instance of the strong interaction between the requirements of the user and the machine organization. The development of content-addressable memories, i.e., memories that can be queried by the content of their entries rather than an address location, are another example of the user's demand triggering new developments. Content-addressed memories have important potential application in the field of recognition systems, in data storage and retrieval, and automatic language translation. Frequently, of course, such functional changes demanded by new uses are difficult or impossible to implement by conventional electronic techniques. The content-addressed memory is an example. Sometimes the interaction also occurs in the opposite direction. New and promising physical technologies emerge that demand unconventional machine design in order to be used to their best advantage. In the next section we shall look at an example.

### *the influence of new techniques*

It may have seemed strange to some readers that we have been discussing computer sciences for so many pages without paying too much attention to the hardware aspects of computers. The reason is that at the moment most of the really burning questions are in the area of proper use and organization of computers rather than in their implementation. Yet in electronic techniques significant changes are taking place that cannot fail to have profound effects on the design of future machines.



a.

b.

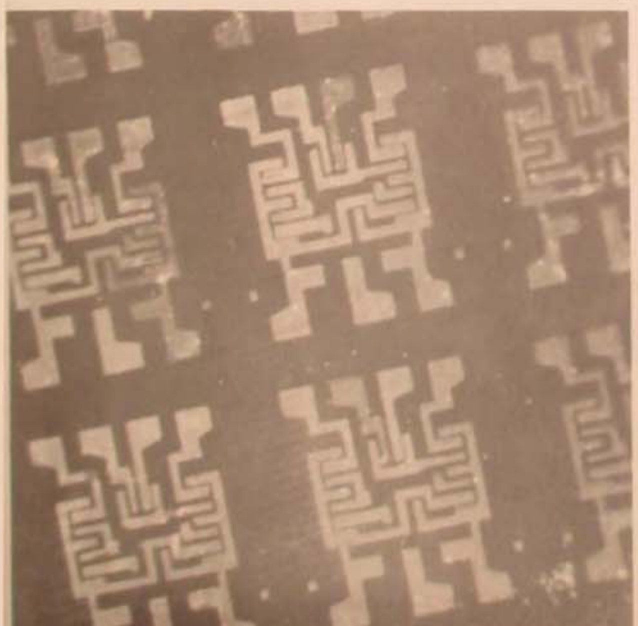


*Figure 5. a. Each of the microcircuits on the circular wafer performs the function of the conventional module shown. b. Detail of the wafer in a. Each microcircuit contains 5 transistors.*

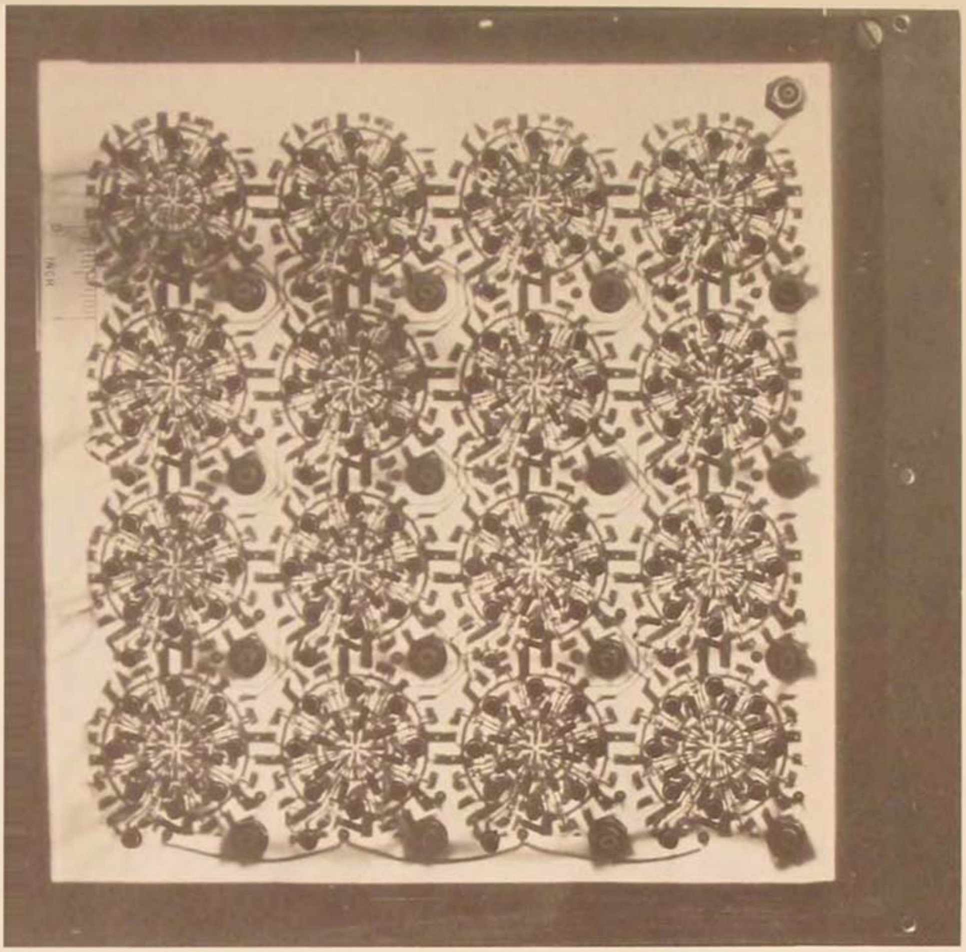
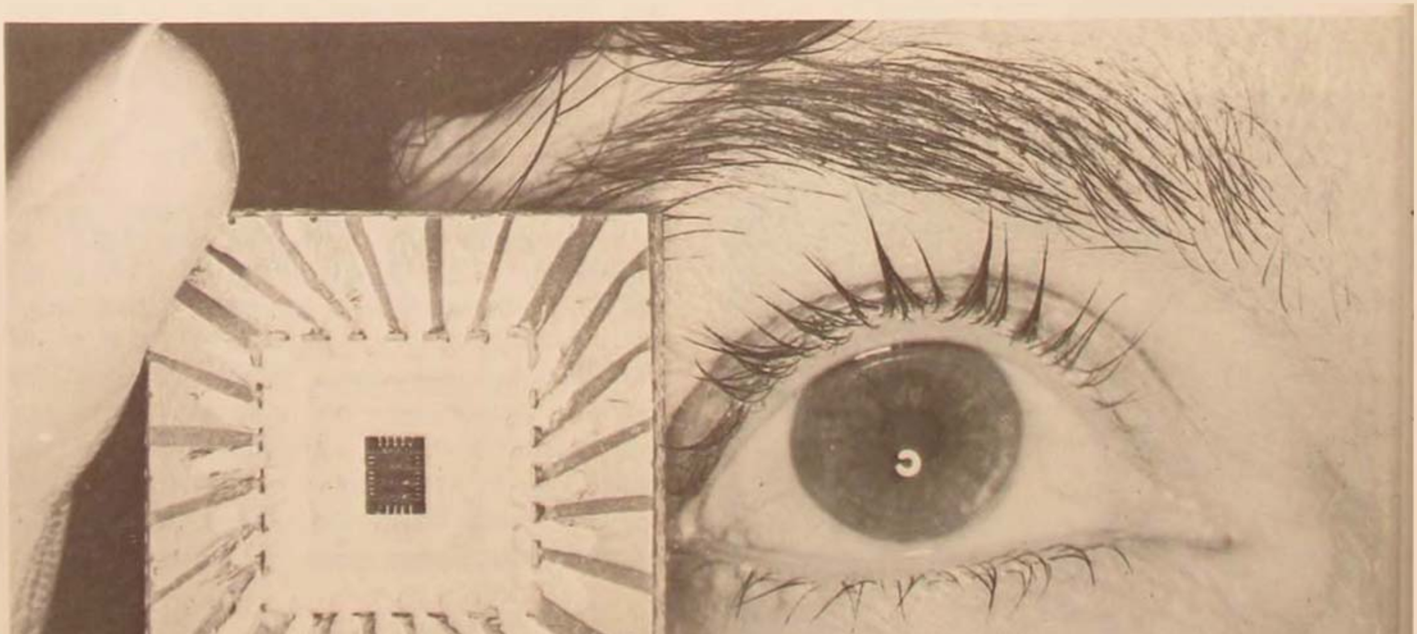


*Figure 6. Model of an iterated net using conventional components*

*Figure 7. The black rectangle on the wafer is the microcircuit equivalent of one segment of the net in Figure 6. The ceramic holder, for easier testing and handling, is eliminated in actual use.*



Various new techniques are either available or in the development stage: integrated circuits, cryogenic devices using the properties of materials at extremely low temperatures, and devices using processes in thin magnetic films for information-processing operations. All these techniques, of which microcircuitry is advancing quickly in the application field, have in common that individual devices are extremely small in size and are produced in bulk processes as opposed to wiring operations connecting lumped components as in conventional circuitry. By use of this technique, a single transistor case the size of a pencil eraser can replace an entire plug-in module of the conventional variety. Without packaging, the picture is even more impressive. Figure 5 shows a silicon wafer containing about 50 integrated circuits, each of which is capable of replacing the plug-in module shown alongside. Further, in the unpackaged form these circuits, in quantity production, promise to be extremely cheap and very reliable. Properly used, they seem for the first time to give us a means of producing entirely different computers without too much restriction on the number of components.

"Properly used" here means that, first, we use elementary circuits which permit us to build up any computer structure using one kind of element only. Such elements do exist. Second, large numbers of such elements should be manufactured on a common substrate with all conductors that might possibly be needed to interconnect elements on the wafer produced in the manufacturing process. Wiring in the traditional sense would be used only at the periphery of an entire array of elements. By additional peripheral coded inputs or by signals requiring no physical contact, such as light patterns or local magnetic fields, the array can then be "structured," i.e., instructed as to which connections should be active and which should be incapacitated.

Logic structures of this general kind have been investigated quite extensively in the recent past. We now have, for the first time, promising techniques to put them into actual operation. We can visualize that in structures of this kind many different processes can take place simultaneously in different regions of the array and, further, that processes involving interactions of happenings in "neighborhoods" are most likely a preferred operating mode. This seems to indicate that these techniques may be particularly suited for applications where spatial relations or structured data fields are involved, and this is the case in many adaptive and pattern-recognition systems and in instances where some sort of field representation is indicated.

So far, only modest models have been built and tested in the laboratory. Figure 6 shows a net of this kind, built of conventional components and containing only 16 elements. If light is projected through a properly punched IBM card (not shown in picture), the net can be made to act as a counter or an oscillator, or a variety of other computer modules. A single element, embedded in a ceramic holder for easier testing and handling, is shown in Figure 7.

An interesting and important problem in this connection is that of reliability. If we make it our goal to produce large numbers of logic elements on one common substrate, we cannot possibly expect to have no faulty elements at all. For reasons of economy, it will not be feasible to discard entire arrays only because of a few faulty elements. Even in the presence of very good yields in terms of individual elements, the discards would outnumber the good arrays astronomically. Also, it might be extremely difficult to conduct exhaustive tests to locate faulty elements. It is therefore necessary to design structures that continue to function reliably in spite of failures of a number of components.

Since we have excluded outright repair of faulty elements, two approaches to our goal remain: self-repair and fault-masking. In the latter case, we leave the faulty elements in the structure (as a matter of fact we have no means of telling that there are faulty components), but we have a sufficient number of additional, redundant elements to maintain the correct function of the array. One way to achieve this, which is particularly suited for very large nets, has recently been under investigation at AFCRL. It is, in essence, a generalization of the technique applied to relay nets by Shannon and Moore in 1956 and applies the principle of iteration as shown in Figure 8. One notes that in 8*a* three elements, shown as circles, are connected in a certain way. In 8*b* we have three configurations identical to 8*a*, which in turn are connected to each other in the same way as the elements were in the original net. In other words, 8*b* results from 8*a* by the replacement of each element by the net itself;

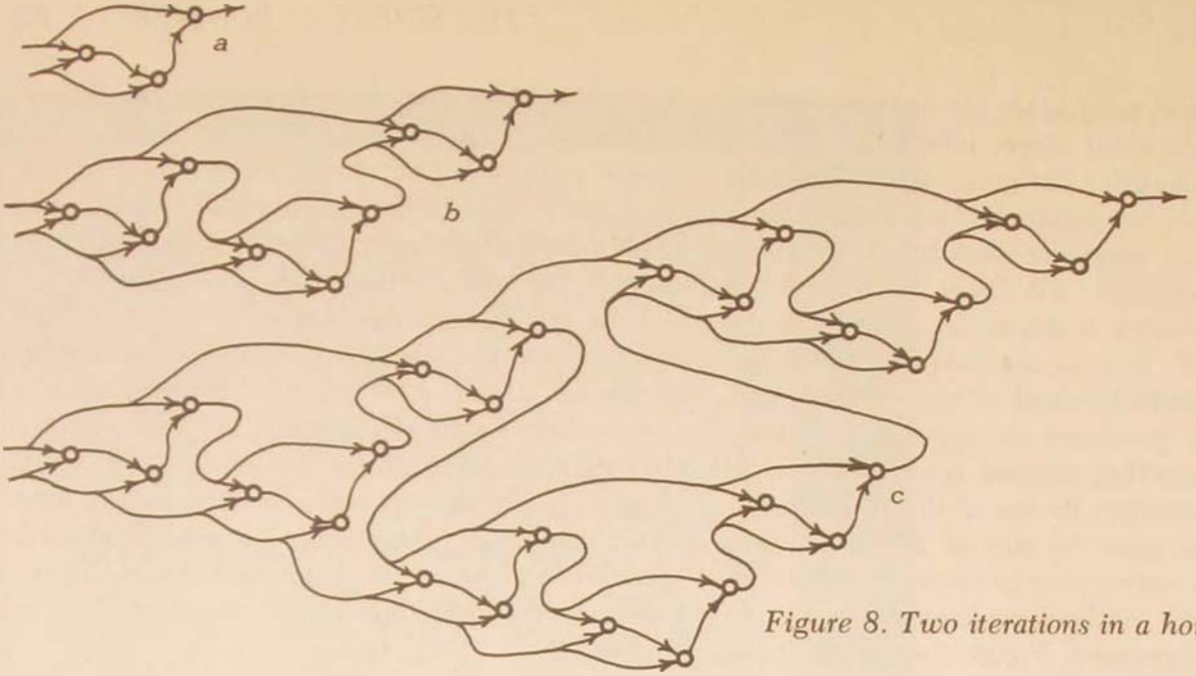



*Figure 8. Two iterations in a homogeneous net*

$c$ results from $b$ in the same manner. In this way arbitrary large nets can be "grown" and their behavior studied. It turns out that by use of this technique arbitrarily reliable nets can be constructed from arbitrarily unreliable elements. Research is proceeding to make practically significant uses of these techniques.

SPACE DOES NOT permit me to relate a large number of equally significant new electronic techniques and their impact on future computer system design. For the same reason I was forced to omit a host of important computer applications, each of which is justly deserving of separate treatment. The areas of information storage and retrieval and automatic translation of languages are but two instances.

In conclusion, let us only briefly consider an aspect of this research towards better and more useful information-processing systems, namely, the interdisciplinary character of this research. Obviously, electronic engineers and circuit designers, as well as logic designers mostly with engineering or mathematics background, have had and will continue to have a deciding influence in the physical design of computers. But consider the advent of integrated circuitry! As bulk processes of fabrication take over, it will become increasingly meaningless to design "circuits" in the conventional sense of combining resistors, capacitors, inductors, and amplifying elements to a circuit. In many cases such lumped components are no longer identifiable; the electronic action takes place in the different regions of a block of material which by designer's choice have been given certain geometries and different electrical characteristics. It becomes more appropriate to describe the action of the devices in terms of the basic physics involved, e.g., in terms of diffusion and combination processing. The voltages at the output terminals—if output terminals there be—result from associated field distributions. Thus physicists take over, at least in part, functions that previously were considered the domain of circuit designers.

Let us turn next to the maker of computer languages. It might appear on first sight that the specification of a programing language is a matter of concern just to an experienced programmer who knows what he wants and has an adequate appreciation of the intended field of application of the language. What he is doing, however, has widespread ramifications touching on widely separated branches of science. First, he is indeed constructing a language, a system of nouns, verbs, and modifiers, governed by grammar and syntax. In fact, since the goal of the programing language is to close the gap between natural and artificial languages, a continuing study of natural as well as artificial languages is necessary. Also, since artificial languages are governed by rigid rules allowing no exceptions, they present a proving ground for a branch of science called mathematical linguistics concerned with formal methods and algorithms of syntactic analysis. This, in turn, has important implications for the analysis and translation of natural languages, one of the more ambitious goals of computer applications.

On the other hand, programing languages, being systems for manipulation of symbols and groups of symbols according to a set of fixed rules and based on certain axioms, are, along with the internal arithmetic of a machine, formal systems in the mathematical sense. This exposes them, in principle at least, to the problems and questions associated with formal systems, which have rocked the world of fundamental mathematics since the start of the century. For instance, a programing language must, first of all, be consistent. Its rules must not permit statements contradicting each other. Further, people concerned with the fundamentals of mathematics are very much concerned with the question of computability, i.e., whether a certain function can be computed within the framework of a given formal system. The relation to computer sciences is obvious. In fact, Turing's hypothetical machine, mentioned at the beginning of this article, was not conceived at all as a design for a computer but as a means to axiomatize the problem of computability.

Let us revert for a moment to the question of consistency of formal systems. It has been proved in Goedel's famous proof (1932) that a formal system must contain at least one statement which, although true, cannot be proved to be true by means of the system itself. In fact each nontrivial* system contains a large number of such statements. There exists a sizable number of theorems in mathematics which have not been disproved but for which a formal proof has not been found in spite of continuing efforts of the most able mathematicians. One fundamental law concerning formal systems tells us that indeed an infinity of such propositions does exist in any formal system rich enough to describe a Turing machine, which, in turn, can be taken as a representative abstraction of any existing computer. These supposed theorems are not provable by the mechanism of the machine by virtue of the fact that such "theorems" are "undecidable." As has been pointed out by Cannonito, this may suggest that the border line between human intellect and that of a machine is delineated by the ability of humans to devise such nonprovable theorems and the lack of that ability in machines.

*A system rich enough to define, say, arithmetic in it.

From their very beginning, computers have attracted the interest of psychologists. The emergence of controllable machinery that displays such behavioral traits as "learning" and conditioned responses and that is able to perform in a primitive way such feats as abstraction and concept formation suggested computers as welcome tools for the modeling of certain ways of behavior. ("Assuming that a rat traversing a maze reasons in a certain way, how would it perform?" A computer simulation can give a quick answer.) More important are the questions of relative effectiveness of humans and machines. More research in that area is of utmost importance. Further, what are the uses of computers in the field of teaching and training? (To mention this topic this late and so briefly is almost inexcusable in the light of the fact that major manufacturers in the computer field expect a very substantial portion of their future business to be in the area of mechanized education. Thus it is not too surprising that a considerable number of researchers in the computer field have a background in psychology or behavioral science.)

Lastly, let us mention the intimate relation between computer sciences and the life sciences. Early catch phrases about computers as "electronic brains" outthinking humans have, fortunately, largely disappeared. But it takes not too much imagination to see the analogy, in performance, not in physical construction, between the large logic nets discussed previously and a nervous structure in a living animal. Both have the capacity to perform certain logic or cognitive functions and to continue to do so in spite of local malfunction.

Many concepts in advanced computer organization have taken clues from the life sciences. In one field, known as bionics, a search is being conducted for biological mechanisms performing certain data-processing tasks that can be duplicated in electronic hardware. Despite the objection that may be raised that, after all, the biological way is only one way to do things and not necessarily the best way, biological systems are nevertheless a valuable way to gain inspiration. Less teleologically oriented research in biological systems serves to verify basic hypotheses of information sciences by investigation of the performance of the living system. Hence our intense interest in the sensory systems of animals and humans. On the other hand the techniques of modern information science provide unprecedented tools to the researcher in the life sciences. This is increasingly being recognized. To prove that this is not a unilateral feeling, I quote from the anatomist D. A. Sholl's well-known book, *The Organization of the Cerebral Cortex:*

> As a final example of the application of recent mathematical developments outside their original domain, we shall note the investigations of the relationship between logic and mathematics. Such a study, one of pure mathematics, might seem to be especially remote from the experiments of the biologist. But the theories of language and logic that emerged from this work have had a far-reaching influence. Apart from the purely philosophical studies, the influence of this work extends from the symbolic expression of biological theories by Woodger to the development of high-speed digital computers.

Many topics worthy of detailed discussion in their own right have not been mentioned at all; others have been treated in perhaps undeserved detail. The reasons for both these shortcomings are, primarily, the author's personal leanings and the desire to present at least some items in detail rather than to attempt to give an exhaustive list. Be that as it may, I feel that I owe the reader a summary of the direction in which I believe computer research will go:

• There is a great deal to be done in improvement of physical techniques. Some of these improvements will increase the capabilities of contemporary machines. To a large extent improvements will take place under the pressure of competition and the need for more capacity along established lines.

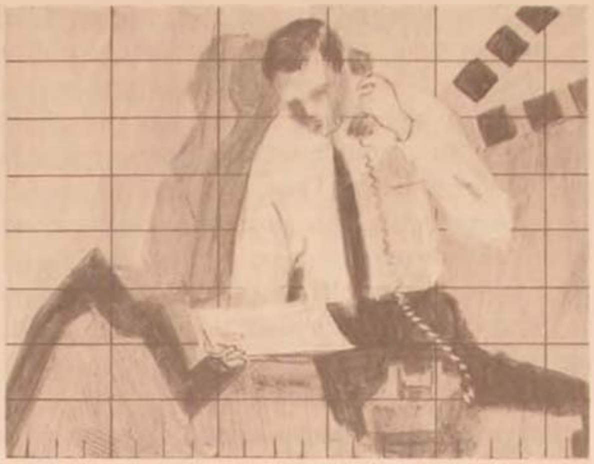
• New techniques make possible, and may even demand, differently structured machines. This, together with the shift from numerical processing to the accomplishment of tasks closer to human reasoning and decision-making, may lead to an entirely new generation of machines.

• The relation between man and machine is in the process of being radically revised. The move towards a free flow of language between user and machine is probably the most important topic in present research.

• The need to draw on the resources of a considerable variety of branches of science encourages the re-emergence of scientists with an interdisciplinary outlook. It may even encourage the proponents of specialized branches of research to mend their ways and try to speak in more universally understandable language. Although a return to the *universitas litterarum* is impossible, research in computer sciences may prove to be a considerable force towards cooperation and mutual understanding among many branches of science.

*Air Force Cambridge Research Laboratories*

# In My Opinion



## ARE WE MISSING THE BOAT IN MANAGEMENT DEVELOPMENT?

MAJOR ROBERT L. ABLE

EVERYWHERE in the literature of today's Air Force one finds repeated references to the great requirement that now exists for sound management practices in the Air Force. General LeMay, in a recent speech before the American Bankers Association, set this requirement into perspective by citing as criteria the capital investment of the Air Force, the number and dispersal of its physical facilities, the size and versatility of personnel strength, the size of the annual expenditure budget, and the dynamic nature of our mission which requires us to stay always ahead of our competitors in the development of the tools and techniques of modern warfare. If we accept these criteria as evidence of the requirement for sound management, it is immediately apparent that the Air Force qualifies on all counts to a greater degree than any private corporation in the United States.

In the same speech, General LeMay reminded his audience that our most important resource is people. He pointed out that "if we fail to use our human resources properly, all prospects for success in other areas are nullified. It is through people that we manage and accomplish our required tasks." Citing the steady escalation in the education levels (and requirements) of Air Force people, the Chief of Staff went on to stress the demand which exists for continuous training: "We in the Air Force are taking advantage of every means available to increase the effectiveness of our management capability at all levels." It is the purpose of this paper to suggest that Air Force supervisors in the field are not utilizing some of the most effective and available tools of management development, even though encouraged by the Chief of Staff and in some cases required to do so by Air Force directives.

To ensure a continuously available supply of adequately prepared people necessitates a planned, overt concern for their development. At the present time the Air Force does not have a specific, integrated program of management development. However, it is not the "program" aspects of such an endeavor which produce the desired results.

Effective management development results from the actual practice of the philosophy and methods of developing the executive talents of management personnel. In a sense, management development is a climate, an environment in which commanders accept as an integral part of their responsibilities the development of their subordinates' abilities. The command line is not only charged with the responsibility of building an effective organization but also with maintaining and perpetuating that level of effectiveness. Thus, to fail in the organization's perpetuation because of a lack of well-trained and developed people is as clearly a command failure as would be the failure to maintain the organization's equipment or physical facilities. A good commander would never let his buildings deteriorate through neglect, to save the expense of preventive maintenance. Similarly, a good commander should never let his people deteriorate through neglect, to save the time necessary for their development. It is the purpose of this paper to measure the extent to which Air Force supervisors are actually using the methods of management development available to them.

### *significance of management development*

The significance of management development in private corporations can be amply documented. Evidence that the demand for managerial talent is increasing more rapidly than for the labor force in general is reflected by the fact that managerial jobs increased 89 per cent from 1940 to 1963 while the labor force increased but 32 per cent and the general population increased 43 per cent.[1] An American Management Association study revealed overt management development activity at 78 per cent of the companies with over 10,000 employees.[2] The National Industrial Conference Board conducted an international study in eight nations and reported a consistent and pervasive concern for the problem.[3] Thus industry has recognized the changes which have taken place in the composition of its work force and has responded with an increased emphasis on the development of managerial talent. A similar composition change is taking place within the Air Force as the World War II blood-and-guts form of charismatic leadership is replaced by the manager skilled in the tools of rational decision-making. Just as an effective path up the ladder in those days was the study and emulation of the successful leader, so today is there a heavy requirement on the aspiring subordinate to learn the skills of his manager superior.

*Internal promotion necessitates internal development.* A significant case can be made for management development on the grounds that the alternatives are unsatisfactory. The requirement for the managerial skills is self-evident for any organization. For private firms, the principal alternative to internal development is to hire away the necessary skills from other firms. The steeply progressive income tax makes this a very expensive alternative. Furthermore, an expanded use of stock options, profit-sharing retirement programs, and similar postwar innovations designed to reduce executive turnover makes this alternative even more unsatisfactory. For the Air Force, the policy of exclusive promotion from within leaves no alternative. We either develop the skills or do without them, and the stakes have become too high for the latter course.

General Electric conducted an intensive study of the paths of ascension followed by its 300 top managers. A principal conclusion of that study was that the natural selection process (or do nothing and hope the cream will rise to the top) supplies neither the number nor the competence level in even a minimum adequate quantity.[4] The Air Force has clearly rejected the "natural selection process" as an adequate solution to the problem and recognizes that there are few "born managers"; most are developed.[5]

The decade of the 1960's presents a particularly critical personnel problem for the Air Force because of the very large proportion of its officers who entered active duty during World War II. These officers have progressed into key positions of command and management and thus embody a substantial proportion of the executive experience of the officer corps. This cluster of experienced officers, usually referred to as the "hump problem," is reflected in the number of officers 40 years of age or over. The percentage of Air Force officers 40 or over, as of 31 May of each year, is as follows:

| 1956 | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|
| 13% | 17% | 18% | 24% | 29% | 31% |

The real significance of these figures lies in their relationship to the Air Force retirement system rather than to any diminishing capability of officers over 40 years of age. This "hump" group began reaching 20 years' active service in 1960 and will therefore be reaching the customary retirement period during the decade of the 1960's. This condition is reflected in a recent survey of 11,499 Air Force officers, which reports the percentage of each rank planning to retire before 1970:[6]

| Colonel | Lt. Colonel | Major | All Officers (except Generals) |
|---|---|---|---|
| 72% | 73% | 74% | 40% |

While similar figures are not available for general officers, their rate of retirement during this period, because of even longer service, would be expected to be similar or greater. Thus, during the current decade, the Air Force must replace nearly three-fourths of its key officers. So, also, must the experience level lost with these officers be replaced if a deterioration in effectiveness is to be avoided.

### *use of selected methods of management development*

With all this support and urgency for management development, one would certainly assume that the Air Force was actively engaged in the various processes that help achieve the stated objective. A review of Air Force directives tends to support General LeMay's assertion that we are taking advantage of every means available to increase the effectiveness of our management capabilities. The real question which must be answered, however, is to what degree "every means available" is actually being utilized by Air Force supervisors to aid in the development of their subordinates' managerial skills.

To find the answer to that question, the author selected five of the methods most frequently employed by industry to develop the managerial skills of its executives. A study was then conducted to determine the extent of their utilization by Air Force supervisors. The five methods selected were counseling, coaching, understudy training, job rotation, and self-development. In addition to being the methods most frequently used in industry, a number of other factors served as the basis for selection of these methods. For one thing, current Air Force directives either recommend or direct their use by Air Force supervisors. Also, none of the selected methods are restricted by direct budgetary limitations; therefore, the Air Force has within its own command prerogatives the means for stimulation and encouragement of a greater use of these methods. Finally, since all of the selected methods are accomplished on-the-job (with the partial exception of self-development), an increase in their utilization involves no new programs or directives but only increased support by all levels of command.

Before discussing the results of this study, we might well establish a common ground of meaning for each of the selected methods. The definitions finally accepted for these methods are the product of an extensive research of the literature of management and are usually consolidations of many different approaches.

*Counseling.* Counseling seeks to change behavior, attitude, or point of view; focuses on objectives, goals, hopes, fears; is person-centered, not job-centered. This type of counseling is conducted by management personnel in the normal course of their responsibilities for getting things done through people. Thus it should not be confused with counseling conducted by clinical psychologists or psychotherapists who seek to obtain deep personal adjustment.

*Coaching.* Coaching has been variously defined but always with major emphasis upon the interrelationship which exists between the superior, the subordinate, and the job. Coaching is here defined as planned, on-the-job experience to impart skills, teach a job, convey facts; focuses on methods; is job-centered, not person-centered.

*Understudy.* The most frequent conception of understudy training postulates the assumption of the superior's role by the subordinate. For the purpose of this study, the Air Force definition is used, viz., training to assume the responsibilities of the supervisor, either as a substitute or as a replacement.

*Job Rotation.* There can be little question regarding the value of learning on the job as a principal means of developing the managerial talents of executives at all levels of an organization. Job rotation is one of the methods of management development which incorporates this principle of learning-by-doing in such a way as to provide experience in a variety of jobs. Some of the conceptions of job rotation found in the literature specify that the movements be planned. However, from the standpoint of developing the managerial abilities of the members of an organization, the really crucial point is that the member receives the broadening experience. It is thus most important that the jobs carry full responsibility, that the responsibility is progressively increased with each job change, and that the jobs are sufficiently differentiated as to require the exercise of different abilities. If these conditions are met, the movement of personnel through job rotation becomes a tool of management development, whether or not such movement is planned solely for that purpose. Since the Air Force does not conduct a program of job rotation planned solely and specifically for the purpose of personnel development, the "planned" portion of these definitions was not carried forward to the composite definition of job rotation used in this study. Here job rotation is defined as the provision of broad experience through periodic movement to increasingly responsible jobs requiring different abilities.

*Self-development.* Throughout the literature of management, one continually finds expressed the concept that management development is individual development. The final responsibility for development lies with the individual himself rather than with the organization. This is not to say that the organization carries no responsibility for the development of the abilities and potential of its people. The organization can create the proper climate by encouraging developmental activities, providing for advanced education, and generally supporting the program. For example, the counseling, coaching, understudy training, and job rotation previously discussed are very valuable media through which the individual's self-development can materialize. Yet in the final analysis the individual concerned must exert significant efforts if any real degree of success is to be achieved. The Air Force recognizes this dual responsibility of the organization and the individual by providing the opportunities for development and then leaving it to the individual to make use of them. An officer's career is his own responsibility, and the Air Force has no intention of "spoon feeding" him. While the organization should provide guidance and assistance in developing a man's abilities, the man himself must actively participate in the process of preparing for an ever increasing level of responsibility.[7]

There are many methods available to the individual for developing his managerial abilities. However, this study is restricted to those tangible activities which can be measured through depth interviews by an interviewer untrained in psychological investigation. These activities include off-duty college courses, professional reading, professional societies, and community organizations.

### *management development activities of Air Force supervisors*

To determine what is actually being done in the Air Force with reference to the five methods of management development under study, we sought a sample of experience of Air Force officers. A sample was desired which would satisfy five basic criteria. *First.* The most important characteristic desired in the sample was that it be sufficiently dispersed so that no single command policy, commander, or supervisor would exert a disproportionate influence on the results. *Second.* A distribution between flying and nonflying officers closely paralleling the total Air Force distribution was desired. The purpose of this criterion was to prevent the peculiarities of a few assignments from distorting the results. *Third.* For the same reason, a distribution similar to that of the total Air Force was sought between operational commands (those charged with a combat mission) and support commands (those charged with a noncombat mission). *Fourth.* A sample was desired which reflected the total Air Force distribution for rank. *Fifth.* Finally, a sample of approximately 100 officers was considered large enough to report reliable answers but small enough to make possible the intensive, face-to-face interviews considered necessary to obtain valid answers to the questions posed.

An organization which closely conforms to these desired criteria and chosen for the sample in this study was the student body of the School of Engineering at the Air Force Institute of Technology (AFIT), Air University Command, Wright-Patterson Air Force Base, Ohio.* All five of the criteria were amply satisfied by the sample chosen.

A significant advantage of this sample is the fact that these officers represent a group which the Air Force has identified as having definite potential for major contribution to the organization in the future. This is evidenced by the highly selective process used in approving AFIT students and by the fact that the Air Force is willing to spend a considerable amount of money on their advanced education. It logically follows that if the Air Force is putting into practice the methods of management development described in its directives, it should certainly be applying them to its relatively junior officers with recognized potential.

A face-to-face, personal interview was held with each officer included in the sample. These interviews were directed discussions in the sense that a questionnaire was used as an interview outline. They were nondirected discussions in the sense that the respondents were encouraged to talk at length and volunteer whatever information they desired.** An analysis of the results of these depth interviews revealed a general failure of supervisors to use the selected methods of management development, with the exception of understudy training.

*Use of Counseling.* Counseling has not been used by most Air Force supervisors as a method of developing the managerial skills of their subordinates. While some 64 per cent of the respondents' supervisors had made some attempt at discussing their annual evaluations with subordinates, 80 per cent had made no attempt to use the discussion as an opportunity to counsel the subordinate regarding his strengths, weaknesses, and performance. The respondents reported this failure to counsel as "very typical" of their careers and not the result of an unusual circumstance during the year reflected by the interview. Some 68 per cent had not been kept continually informed regarding their strengths, weaknesses, and level of achievement, their supervisors disregarding the "good management practices" recommended by the Air Force.[8] Furthermore, 80 per cent of the respondents had not been counseled and assisted by their supervisors in developing long-range career plans, and only 27 per cent had been encouraged to make specific career progress plans. The great bulk of supervisors had thus been disregarding the Air Force's recommendation that "all supervisors counsel and assist subordinate officers in developing long range career plans."[9] The 28 February 1961 edition of the Air Force sample survey asked 11,934 officers if their supervisors had "counseled or assisted you in developing long range career plans."[10] Some 87 per cent reported that they had not received such counseling, which compares favorably with the 80 per cent negative response reported in the present study. Several other studies report similar results.[11]

Further analysis of the data revealed that 94 per cent of the respondents felt that such counseling would have been very beneficial to them. Analysis also revealed that when Air Force supervisors do attempt counseling they do a good job of it, as indicated by the opinions of their counselees and by the degree of conformance to the performance standards. For clarification, it should be noted that the respondents of this sample were reporting on a period in which the Officer Effectiveness Report (OER) was shown to the ratee. However, if 80 per cent of the supervisors were not counseling when such a session was prescribed, on what basis could it be argued that they were doing so six months after the OER, as now stipulated in Air Force Manual 36-10?[12]

*Use of Coaching.* Coaching has been similarly neglected. Some 56 per cent of the respondents had not received any kind of coaching, and 78 per cent had not received coaching designed to develop their managerial skills (the difference being the coaching received in aircraft checkouts). Since this was "very typical" of their careers, the great bulk of the officers had not received the "assistance in developing and understanding the

*It should be clearly understood that the officers comprising this sample were interviewed regarding experiences which had occurred prior to their coming to the Institute. Therefore, the results of this study in no way reflect the practices of AFIT, the Air University Command, or Wright-Patterson Air Force Base, beyond the contribution made by any former member of these commands who happened to be included in the sample.

**For those interested in the research method used, a brief outline of the format is given. An interview guide questionnaire was constructed to ensure a common ground of meaning for all terminology and to ensure that the same appropriate questions, using the same wording, were asked all respondents. Composite conceptions of how each of the selected methods should be accomplished were consolidated from the literature of management. These composites served as the performance standards against which the respondent's experience was compared. An affirmative response was not recorded unless the performance standards had been reasonably satisfied.

skills required for managing both the human and procedural aspects of operations," as recommended by the Air Force[13] and as strongly endorsed by the officers themselves. The respondents' opinions and the conformance to the performance standards again reflected a good job of coaching when attempted.

*Understudy Training*. Air Force supervisors generally do prepare an understudy to take over their responsibilities, either as a substitute or as a replacement. Some 42 per cent of the respondents had been so prepared, and most found this "very typical" of their careers. While it is true that the majority (58 per cent) had not received the training, it should be noted that this training is designed to be given to one subordinate by each supervisor, rather than to all subordinates as is true for counseling and coaching. For example, the Air Force states that "any supervisor should provide someone to act in his place."[14] Thus it is important that the training be provided by each supervisor, rather than be received by each officer. The degree of conformance to the performance standards developed in the literature of management indicated that a good job of understudy training had been done.

*Use of Job Rotation*. In the opinion of 56 per cent of the respondents, the Air Force had not rotated their assignments to develop their managerial abilities. Furthermore, 59 per cent had not received the variety of experience which the Air Force deems appropriate for their rank.[15]

*Interest in Self-Development*. Analysis of this sample revealed that Air Force officers have been far more active in trying to develop themselves than their supervisors have been in encouraging them to do so. Some 53 per cent had not received any encouragement to pursue any of the self-development media under consideration. While 61 per cent had taken USAFI or ECI correspondence courses during the previous year, only 26 per cent had been encouraged to do so. All of the respondents had applied for AFIT, of course, but only 35 per cent had been encouraged to do so. While 32 per cent had taken off-duty college courses (some had been stationed in remote areas where no such opportunities existed), only 22 per cent had been encouraged to do so. Some 25 per cent had pursued a planned program of professional reading, but only 6 per cent had been encouraged to do so.

Several important points made here should be restated for emphasis. For one thing, the Air Force, as a very large organization charged with a vital and dynamic mission and responsible for a staggering capital investment and a substantial annual expenditure, has a very real and continuing requirement for a large body of officer-managers possessing a high level of proficiency in managerial skills. In order to get such officers, our policy of promotion from within leaves us no alternative but to develop them ourselves. Toward that end, Air Force directives clearly prescribe the philosophy and some of the activities which private industry has found to be successful. Unfortunately, no philosophy however conceived, no endorsements however sincere, and no activities however effective will ever elevate the skills of a single manager unless given meaning by the actions of supervisors in the field. The results of the study reported here, as well as other supporting studies, clearly reflect a general lack of such activity on the part of Air Force supervisors.

This neglect would be the more excusable were it not so easily remedied. We could do the job if Air Force supervisors would realize that the perpetuation of organizational effectiveness is as dependent upon the development of human skills as it is upon the development of weapons. This realization would go a long way toward creating an environment of development. In such a climate, numerous opportunities would appear for coaching; prescribed counseling sessions would become meaningful; encouragement would sow the fertile field of self-development; understudies would be prepared to assume the superior's responsibilities; and a variety of experience could be provided that would form the foundation of a career progression substantially escalated from the parochial paths followed by so many today.

What is needed is a pervasive awareness of the need and importance of developing the managerial skills of all officers in the Air Force. To obtain such an awareness, we need the active support of all commanders at all levels of the Air Force. Success in such endeavors lies easily within our ability and within the directives and programs we now incorporate. It is up to the supervisors of the Air Force to give real meaning to the words of their Chief of Staff.

*United States Air Force Academy*

**Notes**

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6. *The U.S. Air Force Personnel Report*, VII, 3 (Washington: Department of the Air Force, 1 February 1962), 34.
7. AFM 25-1, p. 84.
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# Air Force Review


## POSTGRADUATE OFFICER TRAINING FOR PILOT TRAINEES

Captain Alan J. Grill

OFFICER training in Air Training Command's undergraduate pilot training program has recently undergone an extensive revision —a revision necessitated by changes in the curriculums of the precommission schools and by a gradual increase in the educational level of the student pilot input. In revising the program, sound reasoning and research led to the formulation of a "postgraduate" philosophy for the officer training portion of the undergraduate pilot training (UPT) program.

The precommission schools that constitute the primary sources of student input for the UPT program are the Officer Training School (OTS), the Air Force Reserve Officers Training Corps (AFROTC), and the Air Force Academy. Studies of their curriculums revealed that the precommissioning schools were providing adequate instruction in fundamental military skills and in the areas of career development and leadership responsibilities, two areas which along with courses in communicative skills had for years represented the bulk of officer training given to pilot trainees in Air Training Command. This apparent overlap of instruction, combined with the fact that approximately 90 per cent of students entering pilot training today have college degrees and appear to be adequately schooled in the basics of communicative skills, caused Air Training Command to direct an overall comparative study of officer training being conducted in the precommissioning schools and in UPT.

In the course of this study two conflicting concepts appeared. One school of thought advocated the theory that, since present student input consists exclusively of commissioned officers, no further officer training other than general military training is necessary in UPT. The opposing school of thought contended that the officer training conducted by the precommission schools was broad and general and did not properly prepare the student in the officership disciplines unique to the rated officer. The latter school argued the following factors that were revealed through the curriculum comparisons:

- There is no common environment or time element among the precommission schools. AFROTC is conducted in hundreds of civilian educational institutions over a four-year period. OTS is conducted in a military school environment over a three-month period. The Air Force Academy program is conducted in a military school environment over a four-year period. Thus it is extremely difficult to achieve standardization in curriculum and in the depth and quality of officer training conducted in the precommission schools.

- The curriculum of the precommission schools is tailored to cover the broad, overall aspects of officership. There is little emphasis on the unique aspects of the duties, responsibilities, and career development of the rated officer.
- The majority of students entering pilot training (approximately 90 per cent) have had no previous commissioned service.
- Transition from civilian or noncommissioned military status to commissioned officer status creates problems of adjustment. Actual military duty often differs from the expectations gained through theoretical exposure and preparation in a quasi-military environment.
- A large proportion of students entering pilot training have not committed themselves to career status. In some cases students lack a deep motivation to fly and have entered the program to "look it over" and see what it has to offer.

In light of these factors Air Training Command decided that continued officer training was needed to prepare the student to assume the duties of a rated commissioned officer upon completion of the UPT program. These factors also served as the basis for developing the revised curriculum for officer training in the UPT program.

The lack of a common officer training background among student pilots posed significant problems in the development of the revised curriculum. For example, classes entering training in July and August are composed primarily of Air Force Academy graduates. Other classes are a mixture of OTS and AFROTC products. Interspersed among all classes in training are a few officers with previous service, primarily navigators vying for a dual rating, and a few Air National Guard officers, many of whom have had little or no precommission training.

This problem area dictated the need for a rather flexible program that could be adjusted to fill the specific needs of a particular class or, ideally, the needs of an individual. Accordingly a "postgraduate" philosophy was adopted. Under this philosophy ATC would establish the broad guidelines for officer training in UPT but the specifics of instructional material and the depth of training pursued within these guidelines would vary according to the background and needs of each individual class.

With this philosophy in mind, six general objectives for officer training were developed, each of which will receive detailed treatment:

(1) The student must be continuously exposed to exemplary standards of officership and must be motivated to emulate this example.

(2) The student must gain an appreciation and knowledge of the concepts, tradition, and heritage handed down to him by his predecessors in the cockpit.

(3) The student must gain a knowledge of the specific responsibilities and additional duties identified with his rated specialty.

(4) The student must be given opportunities to develop leadership qualities and put previous training and education to use through practical application.

(5) The student must gain an introductory knowledge of the Air Force role in counterinsurgency operations. (This is a USAF requirement.)

(6) The student must attain and maintain a high level of physical fitness.

In developing the revised curriculum, special attention was given to the problem of duplication of training. Since the precommission schools offer instruction in extremely broad subject matter areas, a small amount of duplication had to be accepted in order to provide continuity and logical transition within the UPT program. In the areas where duplication does appear, every effort was made to point the instruction more specifically toward the junior rated officer. A paramount consideration in curriculum development was to move from the general aspects of officership covered in precommissioned training to more specific and narrow areas directly related to junior rated officers.

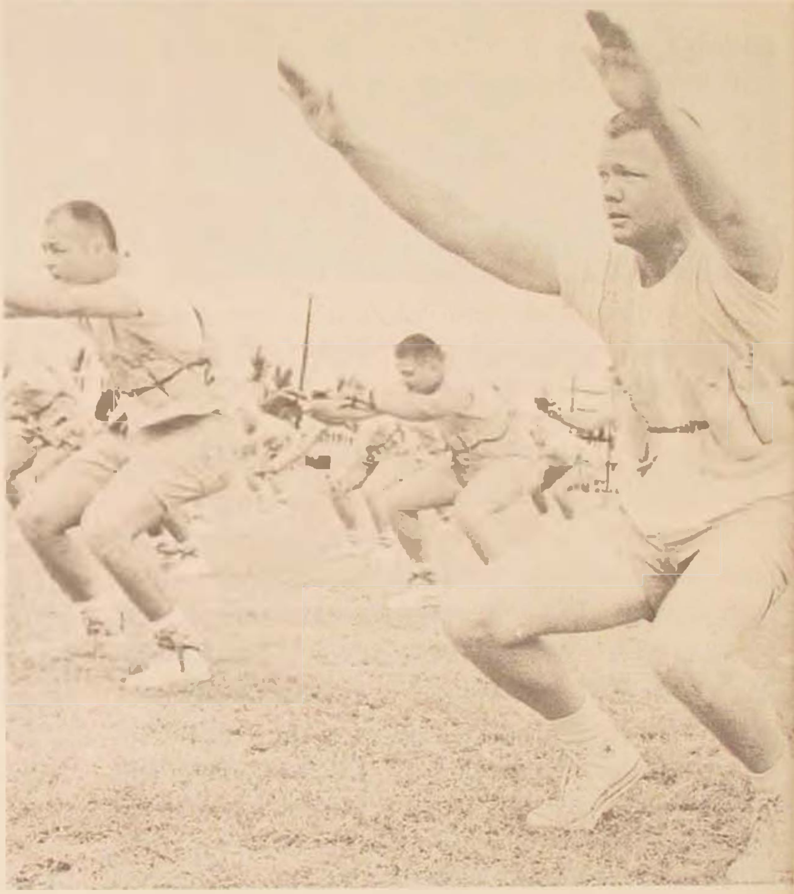
### *leadership by example*

The young officers in the UPT program are normally very impressionable. Therefore one of the most critical considerations in developing the curriculum was to provide effective leadership by example. As will be pointed out later, this leadership factor is an essential element in making a "postgraduate" philosophy workable in a junior officer training program.

The system of leadership by example embodied in the UPT officer training program revolves around an experienced, knowledgeable, professional instructor pilot assigned as the immediate supervisor of each class in training. This professional is known as the officer training instructor (OTI). While the idea of assigning a permanent-party supervisor to each class is not new or unique to the UPT program, it has been refined and developed to a point where the supervisor/student relationship is much closer and more comprehensive than any observed in other programs. Through the OTI system the students are immediately and consistently exposed to exemplary officer-airmanship. Each OTI supervises a class of approximately 45 students.

The OTI's function is extremely broad and diversified. He flies instructional flights with students on a regular basis, provides classroom instruction in officer training subjects, monitors and often participates in physical training with his assigned class, conducts inspections, counsels students as required, prepares Officer Performance and Training Reports on all assigned students, and is responsible for overall coordination of all training activities for his assigned class.

*The rigorous physical training portion of the undergraduate pilot training program is designed to get students into top physical condition and keep them there. In the physical conditioning phase students often wear "Elmer's Handicaps."*



While there are few firmly established prerequisites for qualification to serve as an OTI, most bases generally observe the following criteria:

- captain
- Senior Pilot rating
- one year minimum experience as UPT instructor pilot

- outstanding military bearing
- graduate of Squadron Officer School
- college graduate
- communicative ability
- evidenced leadership ability
- voluntary acceptance of long, hard duty hours
- completion of Academic Instructor Course or equivalent (mandatory).

To be effective, the OTI must be an experienced, highly qualified instructor pilot and must fly with each student in his class as often as possible. This is an essential factor in gaining the respect and confidence of the student and in providing a means to gain insight into the student's total personality, particularly his ability to react in a pressure situation.

To ensure a complete knowledge of each student, the OTI remains with his class for the entire 55-week program, which is broken down into three phases: Preflight, Primary (T-37), and Basic (T-33 or T-38). While flight-line instructors specialize in only one phase of training and in one type of aircraft, the OTI is with his class through all the phases. He greets the class when it arrives, coordinates Preflight training, instructs in the Primary phase of training, continues to instruct his class in the Basic phase, and coordinates the graduation activities for his class. He is qualified in both mission aircraft but maintains currency only in the one in which his class is receiving training.

The OTI normally does not carry assigned students on the flight line. Rather, he circulates throughout the entire class, flying with each student as often as possible. Based on an average monthly flying time of 30 hours, composed of sorties of 1 hour 15 minutes, the OTI will fly 286 sorties with his students during the course of training. This indicates that he will fly approximately seven times with each student in his class. At the request of flight-line supervisors, the OTI will often fly consecutive missions with marginal students. This is done to provide continuity of training and to capitalize on the OTI's flight-instruction experience and personal knowledge of the student.

A major portion of the OTI's job revolves around classroom instruction. The revised UPT syllabus reflects three formal officer training courses: Heritage, Duty, and Counterinsurgency. The postgraduate philosophy prevails in all formal classroom hours and in the many additional classroom hours devoted to special subject matters needed by a particular class. Through his close association with the class, the OTI is able to analyze class needs effectively and tailor needed instruction accordingly.*

In summary, the OTI function is to provide instruction, supervision, and leadership by example for an assigned class of approximately 45 students. (Class size is programed to increase to 62 students in FY 66, which will make the OTI job even more demanding.) By the time his class graduates, the OTI has been closely associated with it for 55 weeks, during which he has observed, monitored, and influenced his students in all areas of training.

It is important to note here that the students are not the only beneficiaries of the OTI system. By maintaining a spirited, well-disciplined student body, the OTI directly assists flight-line personnel in accomplishing their mission more effectively. Furthermore the challenging scope of his job is tremendously broadening for the OTI personally, and the Air Force realizes the corollary benefit of on-the-job training of officers destined for the more demanding leadership positions.

### *Heritage*

To instill an appreciation of the concepts, tradition, and heritage handed down to the student by his predecessors in the cockpit, a 14-hour course titled "Heritage" was developed. In this course students concentrate on the past and present leaders associated with air power, their contributions to air power, and the concepts that they helped to formulate. Since all precommission schools offer some instruction in Air Force history, no attempt is made to cover a detailed chronological development of air power in terms of specific dates, events, and developments.

The course is constructed around four broad periods: development of early air power, air power between the wars, air power in World War II, and the development of modern air power. Each period

*The OTI wife plays an important part in the program. Shortly after a class arrives, she invites the students' wives for coffee, helps them get acquainted, answers their many questions concerning protocol, encourages participation in the Officers Wives Club activities, and stresses the many ways they can help their husbands get through the demanding program. The OTI wife remains the primary adviser and counselor for the class wives throughout the program.

receives a similar treatment. First, the instructor conducts a one-hour lecture and discussion on the major events and personalities associated with that time period. The period involved is too broad to be covered in its entirety, and it is here that the postgraduate philosophy comes into play. The instructor guides the hour, feeling out the class for specific areas of interest. When the class responds to an event or series of events, the instructor builds the remainder of the hour around this area of expressed interest. He then assigns specific personalities and concepts to the students for research in preparation for seminar discussion. After two or three days of preparation, a two-hour seminar discussion of personalities and concepts is conducted. In all seminar activities, classes are broken down into small groups with a student leader. The instructor monitors the seminar, taking notes and observing the participation and communicative skill of the students. At the termination of the seminar, the instructor critiques the discussion and clarifies any unresolved points or vague issues.

Through the study and discussion of past and present Air Force leaders, students are led to an awareness that there is such a trait as patriotism and that valor and fidelity still have a place in this age of sophisticated weaponry. One method of evoking student response to patriotism and valor is to relate typical Medal of Honor citations. No attempt is made to cover up or excuse the fact that mistakes in concept and judgment are also part of the Air Force heritage. By discussing these mistakes, the student benefits from the lessons of history.

To encourage investigation and exploration, the Heritage course is nongraded. Thus instructor and student have complete latitude for exploration. No specific dates, times, and places need be memorized just to be regurgitated for an examination and then forgotten. This has proved to be a significant inspiration in developing interest in the Heritage course.

### *Duty*

To provide the student pilot with a basic knowledge of the specific responsibilities and additional duties associated with his rated specialty, a 20-hour course titled "Duty" was developed. The emphasis throughout this course is on the "fighting man" concept—that the rated officer is a fighting man sworn to protect the ideals of democratic existence, that he must stand ready to fight whatever enemy the President may direct, and that he must master certain responsibilities and disciplines unique to his semi-isolated combat environment.

The first four hours of the Duty course are devoted to a treatment of the freedoms that the rated officer has sworn to defend, the nature of past and present threats to our freedoms, professionalism in the rated officer, the implications of a commission as related to a rated officer, and a review of the Code of Conduct.

Next the students are given an opportunity to discuss various instances of proper and improper behavior of American fighting men, actual or hypothetical, in peacetime and in combat. This is accomplished through a two-hour seminar in which students discuss problem situations. The students have ample time to study the problems and to form definite opinions prior to the seminar.

In keeping with the postgraduate philosophy, typical situations are provided in the Instructor Guide, but instructors are encouraged to use situations or problems of their own selection so that they can capitalize on the class's interests and use personal experience to lead the discussion to important points. All problems are locally reproduced as student handouts.

The next important part of the Duty course deals with the specific duties of junior rated officers in each of the commands. This unit of instruction is designed to assist the student in selecting his assignment following graduation from UPT. Typical data covered include checkout requirements, typical mission profiles, typical additional duties assigned to junior officers, and the amount of flying time the young pilot can expect to receive in each command. One hour in this area is devoted to a panel discussion, using as panelists qualified pilots who have recently returned from the various commands. The panel members are thoroughly briefed to be as objective as possible in their responses and not try either to sell or downgrade a particular command. Students are encouraged to ask questions during this period. Although scheduled as a one-hour period, the panel presentation invariably goes overtime and is usually continued at the Officers Club after duty hours.

Also incorporated into the Duty course is a three-hour block of instruction dealing with rated officer career problems. Objectives of this block are to ensure that the student is aware of the importance of the Effectiveness Report, the importance of education, the fact that each officer has an individual responsibility in career planning, and the major personnel policies governing his career—AFM 36-1, AFM 35-1, and AFM 35-11.

### *Leadership Application*

The culmination of the Duty course is a series of practical leadership problems in which the student is exposed to both leader-assigned and leaderless group problem situations. Throughout the execution of the problems, students are closely observed for aggressiveness, communicative ability, and cooperativeness. Frequently a student in the problem-solving group will be briefed to be an agitator or dissenter, thus complicating the group's task in solving the problem.

Each problem-solving group is critiqued by a group of senior students who have previously accomplished the problems and have been detailed as observers. Thus a valuable by-product is realized in the form of student practice in analysis and critique.

Another invaluable benefit inherent in the practical problem is that it provides an opportunity for the OTI to observe and evaluate his students in practical leadership situations. His observations are valuable later in counseling and in preparing Officer Performance Reports and Training Reports on his assigned students.

The number of practical leadership problems executed depends on the size of the class and the consequent number of problem-solving groups. The maximum recommended group size is ten students, and each student normally participates in at least four different problems.

The presentation of the practical problem unit is necessarily flexible because of varying facil-

*Valuable experience and insight into student leadership ability are gained by practical leadership problems incorporated in the Duty course. Senior students observe and take notes for the critique as pilot trainees solve a "mined road" problem.*

ities at the different UPT bases. Again, problems outlined in the Instructor Guide may be used "as is" or modified to suit local conditions. Problems require frequent revision to preclude compromise and common knowledge of the proper solution.

Perhaps the most important lesson learned by the student in this unit of instruction is the realization that problem recognition and a central source of direction are of utmost importance. Invariably, during the first problem or two, problem-solving groups waste a great deal of time haphazardly trying to solve the problem in a piecemeal fashion. After the first or second problem, however, the students realize that they must analyze the situation and determine where the real problem lies before taking any action.

The Duty course and Leadership Application constitute an exciting, stimulating experience for both the student and the instructor. It is an ideal vehicle for its designed purpose: to acquaint the student with the specific requirements of his future assignment, to impress on him the individual responsibilities in career planning, to remind him of the ideals he has sworn to protect, and to give him an opportunity to display and further develop his leadership abilities. As in Heritage, no formal grade, as such, is given.

### *Counterinsurgency*

A requirement to indoctrinate pilot trainees in the basic elements of counterinsurgency (COIN) operations was established by Headquarters USAF. This requirement fits well into the officer training curriculum in that it provides an opportunity to discuss warfare in terms of present-day problems.

The course starts with a familiarization of the history of insurgency and guerrilla warfare. The student learns that guerrilla tactics are not new, that they date far back in recorded history, and that present-day emphasis on guerrilla tactics stems from the fact that they are ideally suited to insurgency movements. The student learns that insurgency is an increasingly valuable tool to the Communist powers in their quest for world domination.

Other objectives of the course revolve around the causes that underlie and inspire insurgency movements and an understanding of the differences between conventional and guerrilla warfare. The student studies the guerrilla warrior, his background, motivation, training, and political ideology.

In this course students review some of the tactics and operations employed in past counterinsurgency operations by comparing the insurgency movements in Malaya and Indochina. This discussion leads into a study of general techniques and requirements of counterinsurgency operations. The student also learns how U.S. Special Forces employ guerrilla tactics in combating the enemy.

The course includes a discussion on the Air Force role in counterinsurgency operations. Typical items covered are the employment and special characteristics of COIN air power, the aircraft types being used in COIN operations, and those programed for future use.

In a final two-hour seminar the student has an opportunity to review the course and express his views on counterinsurgency.

Since the COIN course is limited to 12 hours, no attempt can be made to provide a thorough understanding of the many complex factors and actions that the subject embodies. Rather, the primary objective is to stimulate interest and encourage further study in this area. Student critiques and seminar performance indicate that this objective is being realized and that the young officers in pilot training find this to be a fascinating subject.

### *physical training*

The importance of maintaining a high state of physical fitness while undergoing a demanding flying training program cannot be overemphasized. During the UPT program students receive a minimum of 143 hours of scheduled physical training. This includes 5BX indoctrination; conditioning exercises with and without wrist, ankle, and vest weights (called "Elmer's Handicaps"); supervised competitive sports; combative training, including judo, boxing, and wrestling; swimming instruction and water survival techniques; and an obstacle course consisting of a rope climb, parallel bars, incline wall, 30-foot tire lane, wall with cargo net, balancing logs, horizontal bars, series of four-foot-high vaults, hand-over-hand, the dirty name, and a jump-and-land.

Three physical fitness tests are administered during the course. Designed to provide an easily administered method of sampling a student's overall physical fitness, the tests consist of sit-ups, pull-ups, and a 300-yard shuttle run. The first test is administered during the 12th and 13th hours of the physical training program, to let both student and instructor know where the student stands at the beginning of the program. The second test is administered during the 60th and 61st hours of training, immediately following the supervised team sports period. This is a graded test, the grade based on the number of pull-ups and sit-ups and the time required to complete the shuttle run. The information gathered from the test is converted to a scoring scale and recorded on ATC Form 99, Physical Fitness Record. The third test is identical to the first and second tests and is administered during the 90th and 91st hours of physical training.

The physical training tests are conducted outdoors. Consequently, temperature and weather variances on testing dates influence the results. Nevertheless the test results do reveal some interesting albeit not rigorously defensible data.

For illustrative purposes, average physical fitness test results of classes 64A and 64B, primarily Academy input, were compared with the average results of classes 64C through 64H, a mixture of OTS, AFROTC, and previous-service personnel inputs. These classes were undergoing training at Webb AFB in FY 64. Test results indicate that all classes progress significantly in their ability to perform the three test items, an apparent indication that the students' general level of physical fitness also improves during the course of training. Interesting to note is the fact that the Academy classes scored higher on initial testing in the pull-up and shuttle run items than the OTS and AFROTC classes. This may indicate that the Academy physical training program stresses upper extremity and running exercises more than the AFROTC and OTS programs. The Academy classes achieved a better final performance in all three test items.

Besides providing a method of maintaining a high degree of physical fitness, the physical training program provides an ideal method of instilling a competitive spirit among the students. Through the competitive sports program, classes compete directly for honors. Class standings and won-and-lost records are posted daily. After-duty play-offs in case of ties are fairly common and are well attended by the rest of the student body. It is not uncommon for a keg of beer to be wagered on the outcome of a highly spirited play-off.

In summary, the physical training portion of the officer training program in UPT is aggressive and fast-moving, designed to get the trainees in shape and keep them there. Corollary benefits are realized from the competitive spirit that the program generates, from the evaluation data provided by formal testing, and from the OTI's being able to observe closely the traits of sportsmanship, cooperation, and competitiveness among his assigned students.

### *augmenting previous experience*

As mentioned earlier, students entering UPT have been exposed to various degrees of previous officer training. The postgraduate philosophy in the UPT officer training program offers many opportunities to extend this previous experience in several ways:

—by assigning existing local problems to students for study and recommended solutions. Students are thus actively encouraged to formulate well-thought-out solutions to problems. Many worthwhile ideas have been realized through this procedure.

—by allowing students to plan and coordinate parade, retreat, dining in, and graduation ceremonies. Although the OTI acts as overall coordinator for these affairs, he delegates the majority of the tasks to the class and evaluates individual student initiative and ingenuity in their accomplishment.

—by assigning students to prepare and present briefings on subjects of interest. Again this area, revolving around the OTI's ability to determine the needs of a particular class, is in keeping with the postgraduate philosophy. This is functional activity in every respect: it provides an opportunity to practice and evaluate communicative skills, brings items of interest to the attention of students and instructors, and uses to great advantage what might otherwise be nonproductive time, e.g., weather days.

—by establishing and observing an organizational structure resembling a squadron within each class. Normally the ranking officers are appointed to the command positions in the class; however, Webb AFB is enjoying great success with a system in which internal class command positions are periodically rotated among the more junior officers, thus giving them an opportunity to gain leadership experience.

In these ways the student body's exercise of initiative and imagination enables both the UPT program and the students to benefit from previous leadership experience.

### evaluation

A formidable problem in developing the revised officer training program arose in the area of evaluation. While paper-and-pencil tests provide a practical method of gathering evidence about certain types of student behavior, the behavioral changes sought through officer training were considered too intangible to be appraised validly through that medium. The overall objectives of the officer training program represent personal, social, and idealistic adjustment, and therefore they are realistically appraisable only through actual observation of student behavior in actual performance situations.

The solution to the problem of evaluation stemmed from the belief that the students should be evaluated in the same manner that would eventually be used to evaluate them in the field—through performance or effectiveness ratings. However, the overall standards of an evaluation method—objectivity, reliability, and validity—were matters of serious concern and not easily resolved.

Two primary criteria for evaluating officer training were established:

(1) The evaluation system must appraise actual student behavior, not the mere ability to recall facts and figures.

(2) The evaluation system must incorporate frequent appraisals in order to identify changes that may be occurring.

The OTI, through his close daily association with the students, was the logical agent to appraise actual student behavior. To increase the objectivity of his rating, the OTI solicits and compiles additional observations from flight and academic instructors.

Officer Performance Ratings (OPR) are rendered twice on each student—after the 24th week and after the 48th week of training. The form used, ATC Form 332, closely resembles AF Form 77, Officer Effectiveness Report. Through its use the OTI converts descriptive statements of behavioral traits to a standard score grade as explained in ATC Manual 50-4, *Improvement of Grading Practices in ATC Schools*. Data from the Officer Performance Rating are also used by the OTI to prepare student final Training Report, AF Form 475.

To prevent inflated ratings, the OTI is required to maintain an average raw score of 21 for his class. This is the average, straight-down-the-middle rating, and when converted it equals a standard score of approximately 85. A standard score of 77 or below is considered to be failing. This equates to a raw score of approximately 17 or below on current conversion scales. A student receiving a failing OPR grade is given a reasonable amount of time, six to eight weeks, to demonstrate improvement. If he fails to show satisfactory improvement, he is recommended for military elimination from the program and for consequent action under AFR 36-2 or AFR 36-3.

The standard scores rendered on the two Officer Performance Ratings constitute 80 per cent of the student's final officer training grade. The remaining 20 per cent is obtained from performance results in physical training (10 per cent) and formal evaluation in the COIN course (10 per cent). The final officer training grade constitutes one third of the student's final grade for the UPT course. The remaining two thirds of the overall grade are derived equally from performance in flying training and academic training.

The subjective evaluation system designed for the revised officer training program is a rather radical departure from standard grading procedures and practices in most other training programs. It was designed to be compatible with the postgraduate philosophy of the program and to impress on the student that his "grade," so to speak, when he gets out into the field will be his effectiveness report. The method of grading and the weight given officer training grades underscore the importance of effective officership and emphasize the underlying notion that the development of officership traits is paramount in the final analysis of Air Force needs.

There is a definite need for officer training in the undergraduate pilot training program despite the fact that student input consists of commissioned officers. The revised officer training program developed for the UPT program was designed to emphasize the need for officer quality, to provide an appreciation of Air Force heritage and tradition, to qualify students for effective performance in their postgraduation assignments, to increase student awareness of the Air Force role in counterinsurgency operations, and to maintain a high degree of physical fitness among students undergoing training.

In the pursuit of these objectives, emphasis is placed on the spirit of patriotism, valor, and fidelity—traits too often dismissed as being old-fashioned in this day of modern, sophisticated weaponry. Leadership by example and continuous reference to the three meaningful concepts—Duty, Honor, Country—are the primary ingredients of the new revised officer training program in UPT.

Through the postgraduate approach to officer training, Air Training Command is realizing the exciting, stimulating experience of instilling a love of service and duty and a quest for professionalism among the fledgling rated officer force. As long as the program achieves this purpose, the time and effort expended in continuing officer training will certainly be worthwhile.

*3560th Pilot Training Wing*

*Acknowledgment*

The author, as Chief, Officer Training, Webb AFB, had the assistance of the Officer Training Instructors at each undergraduate pilot training base and at James Connally AFB in constructing the new UPT course. Captains James W. Marlin, Jr., and Robert H. Laurine of Webb AFB made significant contribution to the preparation of this article.

# AIR FORCE OFFICER EDUCATION

Colonel John P. Lisack

A NUMBER of important aspects of the Air Force officer corps are slowly but surely changing. One of these is officer education. Not only is the career of every officer affected directly by his educational attainments, but the very nature and effectiveness of the Air Force is involved.

Although I shall treat essentially the specialized education and the professional military education needs of the Air Force officer, at least four distinguishable elements should be present in the education of any professional:

• In order to fulfill his civic duties as a citizen and live an enjoyable, informed, and effective personal life, he must have the necessary general education.

• His education must include the broad theoretical base required for his professional practice.

• He must have mastery over the specialized knowledge and technical skills which characterize his profession. (In this regard military activities are unique; they are not solely technological or mechanical nor are they commercial, societal, or the like. Hence the military profession is a distinct one.)

• He must keep mentally active continuously in both the general and professional categories. He may do this on a formal or informal basis, either individually or in a group educational program.

It can be readily seen that the Air Force policy of procuring officers initially with the bachelor degree and providing subsequent specialized and professional military educational programs is in consonance with and supports these professional qualifications. The Air Force recognizes that education affects the quality of both consciousness and behavior.

Broadly speaking, officer education may be considered in two categories—specialized education and professional military education. I shall describe each briefly and then discuss both in some detail.

Specialized education in the Air Force is essentially civilian college-type study that relates to each Air Force specialty. These studies normally take place in an accredited college or university. The Air Force Educational Requirements Board has identified and described the educational levels and appropriate fields of specialized study that are needed for full qualification for each officer AF specialty. Further, the *Officer Classification Manual*, AFM 36-1, has a paragraph describing the broad minimum educational requirements for each specialty. In other words, specialized educational requirements have been fairly well described and recorded.

Specialized education is largely given to AF officers through the formal resident programs of the Air Force Institute of Technology at Wright-Patterson AFB, Ohio, or through civilian universities under AFIT contractual arrangements. In addition thousands of Air Force officers are engaged in specialized educational programs through Bootstrap and "on their own."

A project now nearing completion defines, categorizes, and codes all specialized educational terms. Very soon each officer's education will be accurately reported, and by means of electronic data-processing techniques his specific educational attainments, by level and field of study, can be quickly ascertained. This project will make specialized education more important and meaningful in personnel and manpower management actions.

On the other hand, professional military education (PME) is made up essentially of the education required for the development of a professional military officer regardless of his specialty. Programs that provide this education pertain largely to the military arts and sciences. There is necessarily some overlap with what are normally considered to be specialized educational subjects because the profession of arms includes consideration of many of the well-recognized collegiate-type fields of study. Military science builds on these specialized studies. For example, selected studies in the social sciences, engineering and physical sciences, administration and management, to name a few, are elements of military science. However, the broad context in which all PME studies are made relates primarily to national security from a military standpoint, and the specific educational objectives pertain essentially to the continuing development of a professional military officer. PME is therefore necessarily conducted in schools and colleges controlled and administered by the military. For USAF officers formal PME studies begin with military subjects in the officer precommissioning programs, extend through the Squadron Officer School for lieutenants and captains, the Air Command and Staff College for captains and majors, and the Air War College for lieutenant colonels. The military staff and war colleges of our sister services and the joint military colleges (such as the Armed Forces Staff College, the Industrial College of the Armed Forces, and the National War College) broaden and top off the PME system of the U.S. armed services.* Allied officers share in many of these U.S. programs, and reciprocal arrangements have been worked out for representatives of our services to attend PME schools of our allies.

Many writers have claimed that a basic conflict exists between the two officer educational categories, the contention often being based largely on the argument that large numbers of officers are required as "specialists" and not as "military generalists." They claim that keeping abreast as a specialist, particularly in some of the scientific fields, leaves little or no time for military education. Further, they may ask: If the officer is employed as a specialist, why does he need professional military education?

A basic conflict does not exist because every officer is necessarily both a specialist and a professional military man. There is no officer who does not have an Air Force specialty that requires specialized skills (and most have a number of them), and there is no man or woman who is a lieutenant or captain or field-grader who is not an officer too. Frequently where specialist skills alone are needed, civilians supply them or contractual arrangements are made. In any event sufficient numbers of active duty and reserve military personnel must be available to progress to the higher military officer positions, and sufficient numbers must be trained and ready to meet war plan requirements. While it is true that some officers are engaged more in specialized work than in general military duties, both elements are always found to some degree in every position or job filled by an officer. It is also important to realize that these relationships may vary as an officer progresses in his career or serves under wartime conditions. Thus it can be seen that a "conflict" exists only if one is determined to cast all officers in a rigid mold and retain the casting configuration indefinitely.

The changing nature of an officer's responsibilities is indicated in Air Force Regulation 36-23:

> Managerial responsibility is inherent within each officer position. Normally, it increases in proportion to the officer's progression to higher and more responsible positions. In senior field grade positions, managerial ability usually outweighs the requirements for specific technical job knowledge, except in some of the most highly complex specialties such as chemist, metallurgist, weather officer, procurement officer, and intelligence officer.
>
> Officers will be relatively narrowly specialized in the early years of their careers to develop the technical competence required and to provide a sound foundation for further career development. This is essential for those who will further specialize, and serves as the base on which to provide broadening for those progressing towards the status of qualified senior officers. Broadening utilization must be com-

*The Air Training Command is responsible for conducting pilot and navigator training programs and technical training courses to meet specific officer job requirements. Although these include study of subjects which are in the area of PME, they are separate from the two major categories of specialized and professional military education and are not considered here.

mensurate with the officer's increase in experience, grade, qualifications, and capability.

It is a fact that even in the scientific specialties many officers who do research at squadron officer level are called upon to direct and manage research and development activities at the field-grade officer level. As the management level increases, more military considerations are necessarily included.

### *specialized education*

An officer's specialized educational attainments are depicted in large part by the earning of an academic degree at the bachelor's, master's, or doctor's level. The general areas of study and major academic fields, from accounting to zoology, are usually identified with an academic degree and are fairly well known. The knowledge and understanding acquired through studies in certain of these academic fields are directly applicable to specific Air Force specialties. They help the officer to become proficient in the duties and responsibilities unique to the specialty, such as accounting for a comptroller or meteorology for a weather officer. It is always important—but even more important under austere conditions—that the type and level of education essential to mission accomplishment be identified and achieved and the officer be utilized accordingly. The latter requirement dictates that positions calling for graduate-level education be identified throughout the Air Force.

In order to view the specialized educational characteristics of Air Force officers in proper perspective, one must look back to World War II when enormous numbers of young men who had little or no formal college education were trained as pilots and navigators through the Aviation Cadet Training Program. This program has continued since the war with little change up to recent times, and a large segment of the present officer corps was procured through it. The Aviation Cadet Program officer input, compared with all other officer procurement programs of the past, is reflected in the present composition of the officer population as shown in Figure 1.*

An immediate generalization about officer education can be made from this chart: that only about one third of the present officer corps has come from precommissioning programs

*Data for this and following charts were obtained from USAF Officer Master File as of 31 May 1963. All Air Force officers are included.

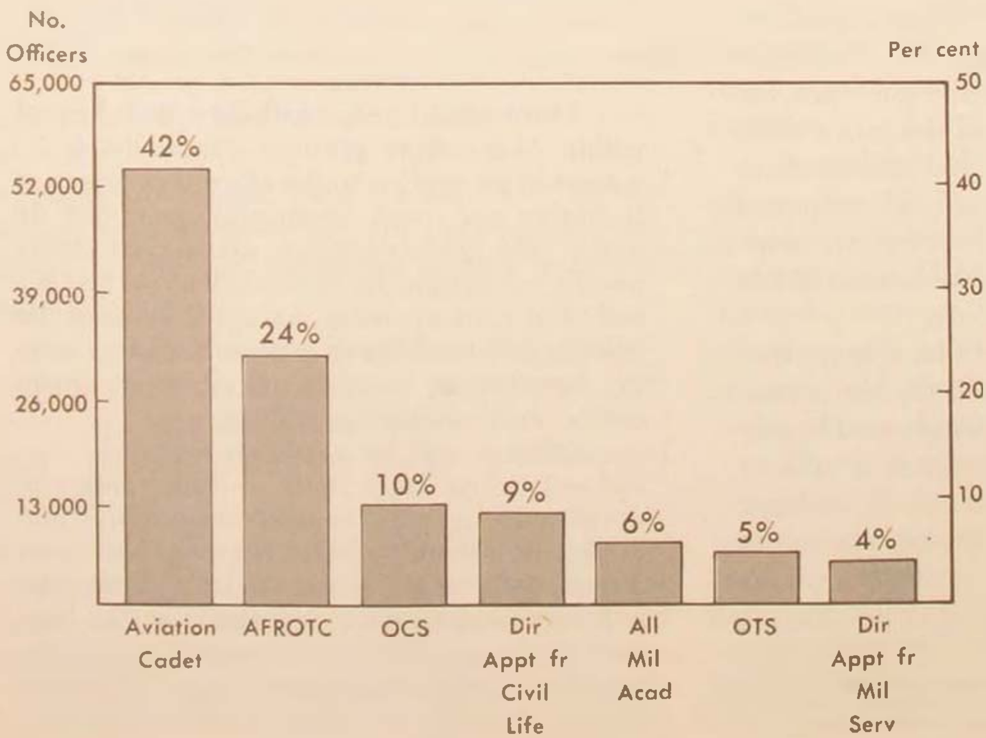



*Figure 1. Officer population by source of commission*

which require a college degree to qualify for the program or that resulted in the award of a degree upon completion. These sources include the AFROTC, the academies, and the Officer Training School. As a result, until a few years ago, less than half of the line officers in the Air Force had achieved a college degree.

The minimum educational standards applied in World War II remained in effect for officer procurement programs for nearly 15 years after the end of the war. Then came a change.

An important personnel goal, namely, that each officer should have at least a bachelor's degree, has been revived through the increasing recognition of the need for adequate educational preparation in all areas of aerospace endeavor. This recognition has been abetted by the specific findings of the Air Force Educational Requirements Board, stimulated by the pressures of increased individual performance requirements and advancing technical requirements, and further jolted by the competition of foreign powers in space and modern weapon systems development.

Implementing actions in support of this new policy are having a direct and measurable effect on the composition of the officer corps and its specialized educational levels. Line officers (except for a small number in navigator training) are not now being procured through any program unless they already have a degree or are awarded one upon completion of the precommissioning program. The Airman Education and Commissioning Program, which culminates in the award of a college degree, has replaced Officer Candidate School, and only graduates of civilian colleges or the academies are going into pilot training. Further, it is noteworthy that the number of cadets in the Air Force Academy is being increased.

*Educational Level by Years of Service and Grade.* The results of the older officer procurement policies, most of which did not emphasize education, and the newer ones which do, are vividly depicted in Figure 2. It is clear that a larger percentage of new officers have bachelor's degrees. Also, the more years' service officers have, the fewer of them have college degrees.

Because of the preceding disclosure and the fact that an even higher percentage of newly procured officers have degrees, at first blush it appears that an anomaly exists: that senior-grade officers have lower educational levels than their juniors. However, such is not the case. The fact of the matter is that *despite* the lower average education level of each sequentially older group, the better-educated officers as a rule have been the ones who were promoted over the years. The generals as a group have a higher educational level than the colonels, and the lieutenant colonels and majors are each sequentially lower. Since new officer procurement policies emphasize education, a high percentage of all lieutenants have degrees, and the higher proportion is beginning to show at the captain grade. The officer education levels are shown by grade in Figure 3.

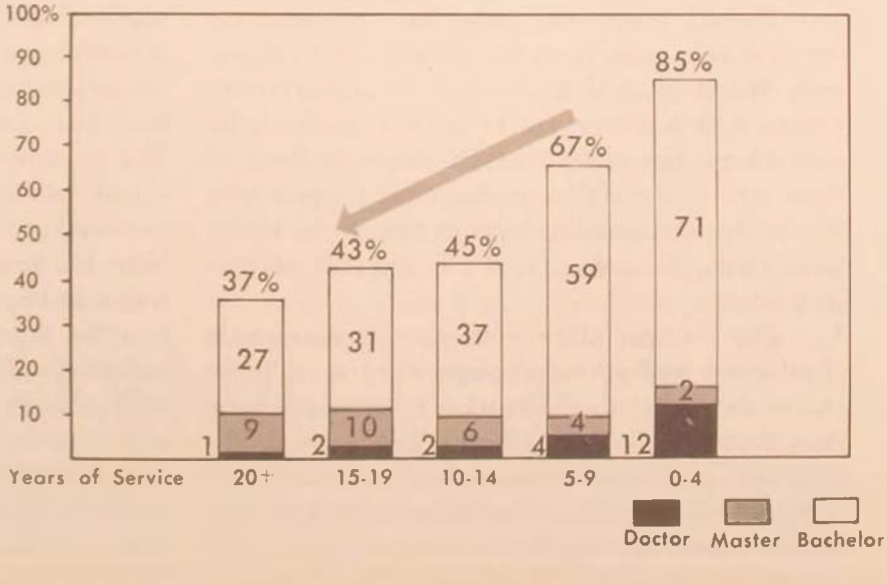



*Figure 2. Officer educational levels shown by years of total active Federal military service*

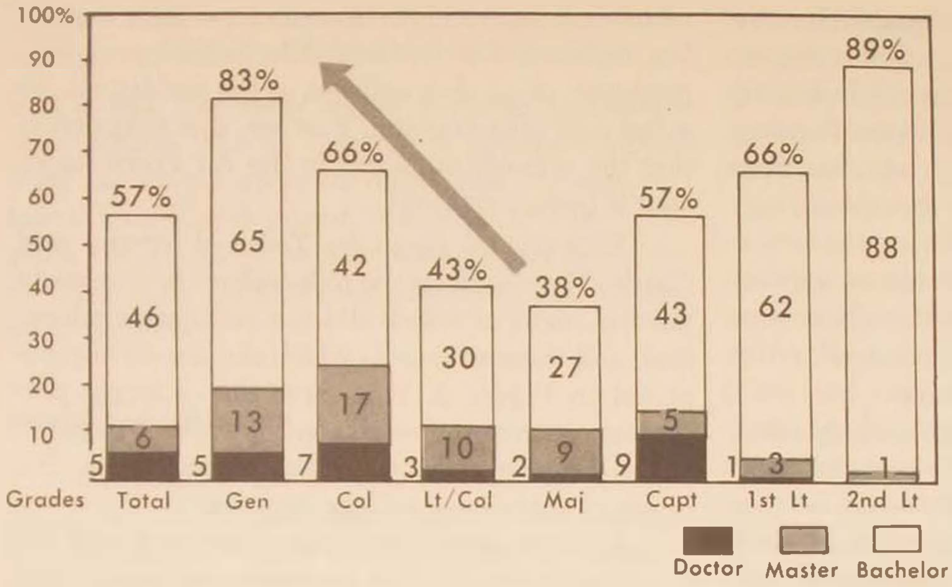



*Figure 3. Officer educational levels by grade*

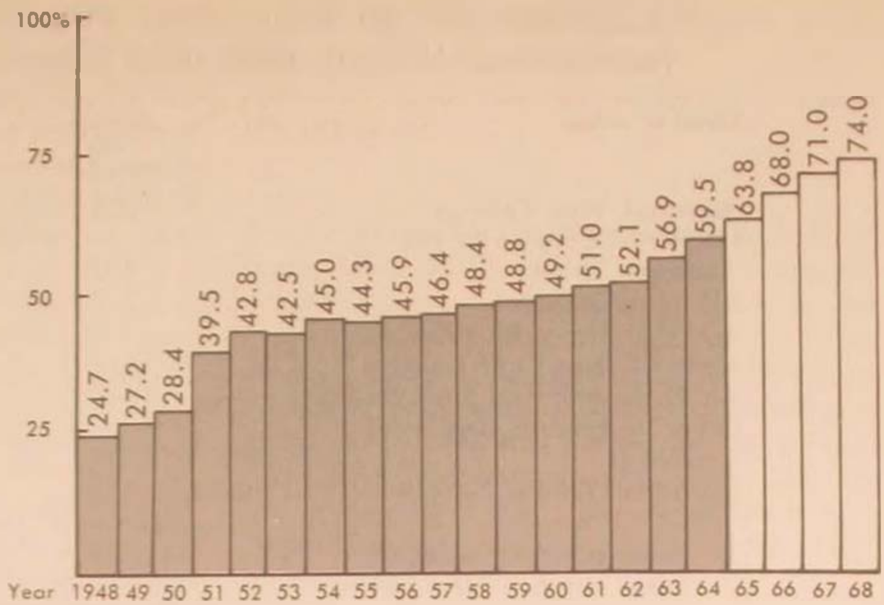
It is clear that a selection system has been at work resulting in promotions to field grades for those with college degrees despite the progressively lower average educational levels of the older groups of which they are a part. It might be argued that the reason generals and colonels have a higher formal educational level is that they have been in the service longer and have had more time and opportunity to advance their education. If this contention were true the down line pattern shown in Figure 2 would then be reversed, or at least it would resemble the saddle contour in Figure 3. Another interesting fact is that there is a positive correlation between the higher-level degrees and the higher grades.

The Air Force will suffer heavy losses over the next few years from the retirement of officers with World War II experience. It appears from Figure 3 that officers in the middle grades, who will inherit the authority and responsibilities of those now in the higher grades, must prepare now for the opportunities and duties soon to be thrust upon them. Education is a key element of that preparation.

The younger officers are moving in a circle of relatively well-educated peers. The data in these charts show that their situation is quite different from that of their senior officers. The younger officers have a better formal college educational base. These officers will undoubtedly be better prepared to meet many of the more advanced specialized problems of the aerospace age which they will face. This specialized educational base—in the proper fields of study—will be the foundation upon which to build those skills needed for the increasingly complex duties and responsibilities.

The Air Force Educational Requirements Board (AFERB) has clearly established that to meet future needs higher levels of specialized education will be required. This should surprise no one, for a like trend is evident in most civilian professions and vocations. Because things are moving ever faster, the job of keeping abreast of and contributing to the advancements in his chosen field will become a greater challenge to each officer.

No doubt many readers have determined just where they fit into each of the charts. I am convinced that no matter where it might be, each officer can rest assured that if he keeps standing still, the chances are that he will soon be left behind. This is borne out by a look at the past record and a look into the future, for which some computations and predictions can be made. (See Figure 4.) Note the progress made in 1950 and 1951. This is due in large part to the recall of reserve officers to meet the Korean crisis, many of whom took advantage of the G.I. Education Bill and went to college after World War II. The emphasis on education in the 1960's is also beginning to show. The Sample Survey of Air Force Officers as of March 1964 indicated that over 56 per cent of all officers had achieved a bachelor's or higher de-




*…ure 4. Percentage of Air Force …ers with college degrees (actual … projected) as of February 1964*

gree. The future trend reflects the attrition from the force of officers procured through the sources of years past, the effects of new personnel policies and goals, and the unprecedented and laudable efforts on the part of thousands of officers now improving their educational levels.

***professional military education***

An officer's professional military educational attainments are most frequently identified by noting which PME programs he has completed. This practice is probably due in part to the habit of measuring specialized education by the degrees awarded. In fact, some writers equate the Air Command and Staff College and Air War College with the master's degree level. Their position is somewhat reinforced by the recommendation of the American Council on Education to award some graduate-level credits for successful completion of these two top Air Force PME college programs.

I believe that some equivalence of military professional education has been acquired by officers through the broad variety of assignments earlier in their careers and through direct military combat experience. However, specialties have become narrower and assignment variety has lessened, and there has been only little chance for combat experience since that great war in the 40's. Korea, the Cuban crisis beginning in October 1962, and now Viet Nam have provided this experience on a limited basis for a few officers. The pressing need of maintaining a high state of operational readiness continues to provide closely related experiences for others.

In this discussion of education for military professionalism, the *raison d'être* and nature of the organization are relevant. Therefore, the specific provisions of the law are pertinent as set forth in U.S. Code 10, Section 8062, which reads, in part, that the armed forces must be capable of

(1) preserving the peace and security, and providing for the defense, of the United States;

(2) supporting the national policies;

(3) implementing the national objectives; and

(4) overcoming any nations responsible for aggressive acts that imperil the peace and security of the United States.

Further, the oath of office states clearly that each officer "affirms to support and defend the Constitution of the United States against all enemies, foreign and domestic . . ."

There is little question that the intent of the law and the oath of office is military oriented. One can scarcely argue that some of the persons who elect to become members of the armed forces and take the oath are specialists (civilian type) and not military men.

It has been stated earlier that the level of actual military-professional knowledge, the military combat experience of officers, and the need for professional military education vary widely.

## AF Officers Still on Active Duty Who Have Attended Professional Military Education Schools or Colleges

| School or college | Number who attended* | Percentage of AF off. who attended* | Percentage of class who are reg AF |
|---|---|---|---|
| National War College | 305 | .23 | 99.67 |
| Industrial College of the Armed Forces | 352 | .27 | 93.75 |
| Air War College | 1243 | .95 | 97.67 |
| Army or Navy War College | 263 | .20 | 89.35 |
| Armed Forces Staff College | 1296 | .99 | 96.06 |
| Air Command and Staff College | 9942 | 7.58 | 82.73 |
| Other command and staff colleges | 1712 | 1.31 | 87.91 |
| Squadron Officer School | 32,545 | 24.82 | 57.66 |
| Total number enrolled | 47,658 | 36.35%* | 66.77% |
| Total number who have not attended | 92,990** | 70.93 | |
| Totals | 140,648** | 107.28%** | |
| Actual officer strength | 131,101 | | |

*Since the USAF Master File lists only the three highest schools attended, the numbers represent enrollments rather than individual officers; the numbers are incomplete at the lower levels because some officers may have attended more than three schools (although this is not too common).

**Multiple enrollments therefore account for the additional 9547 officers (7.28%) over actual officer strength.

The required PME programs are therefore understandably very difficult to define. PME involves the acquisition of knowledge, skills, and attitudes that are requisite to military professionalism, and the knowledge and experience of the officers concerned must be considered. PME is also needed to ensure that a professional military officer realizes that he is engaged in war even as he strives to deter it. He must be conditioned to expect war at various scales and, whatever its intensity, be effective in his role. *All* officers are associated to some degree with either present or future combat or combat supporting units, and each manages resources or monitors activities related to the mission; each should understand and be effective in his commanding, directing, planning, operating, or supporting roles in peace and in war. Further, each will do his particular jobs more effectively when he understands how they contribute to the achievement of the primary Air Force missions and how these support national security objectives. We cannot afford to have military officers on board who picture themselves as civilian-type specialists who are spectators to the acts of deterring war or conducting a hot war once it has begun. All officers are members of the armed forces, and deterring war or conducting it is their business.

The reason for a continuous educational process is to ensure that an officer's professional military understandings are in line with his higher military grade, which determines his authority and responsibility. It was said that specialized education helps the officer to become proficient in the duties and responsibilities of his specialty; PME helps him to become a more proficient officer and increases his knowledge in the military arts and sciences. The learning objectives of PME at lower level usually help the junior officer to acquire understandings concerning military subjects pertinent to lower military organization echelons and facilitate his ability to apply this knowledge meaningfully. As he advances in his career—gains experience and maturity—he may be selected to attend more advanced PME studies. The depth of learning then increases, to improve his ability to synthesize and evaluate data concerning military and national security problems of broader scope. Not all officers require the most advanced PME programs, and not all attend. In fact, as indicated in the accompanying chart, less than two per cent of Air Force officers now on active duty have completed a war college-level program. The largest percentage of officers who attend the more advanced programs are regular Air Force officers. Only at the squadron officer level do the reservists attend in any large proportion.

All officers are professional military men. Therefore, all need a military professional base, which must be updated continuously. Not all officers need the most advanced PME, nor do all have or need the characteristics to excel as "military tigers."

Completion of the first-level AF PME (Squadron Officer School) is now required for all career officers, by correspondence if not by the resident program. Many officers believe that the broad military experiences under combat conditions of the bulk of the present field-grade officers have not yet made it necessary to post a mandatory requirement for officers to complete the second-level AF PME. I predict, however, that the time is nearing when such will be the case.

Although junior officers are better prepared in specialized education and become proficient in their specialty relatively early in their careers, they are less well experienced on their military professional side. AF PME can and should help meet this deficiency.

THE EDUCATION of each officer must be both realistic and idealistic—the former because it must meet present and near future needs, the latter because it must help to develop each officer to his fullest potential. Officers who have argued for either specialized or professional military educational programs must realize that neither one can be neglected for himself or for those he leads. They are both necessary in the career development of a professional military officer. The late philosopher Alfred North Whitehead said it well:

> In the conditions of modern life the rule is absolute: the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated.

*Air Force Educational Requirements Board*

## A Description of the Professional Air Force Officer

**THE professional Air Force officer is the aerospace expert of the Nation's fighting forces. He understands the nature of war and is proficient in the art of waging it under any level of conflict. He is a leader of men in both peace and war, and he is accomplished in utilizing his knowledge and skills in organizing and managing resources.**

**He combines military bearing and self-confidence with loyalty, integrity, self-discipline, versatility and adaptability. His conduct and ethics are based upon the ideal of service above self.**

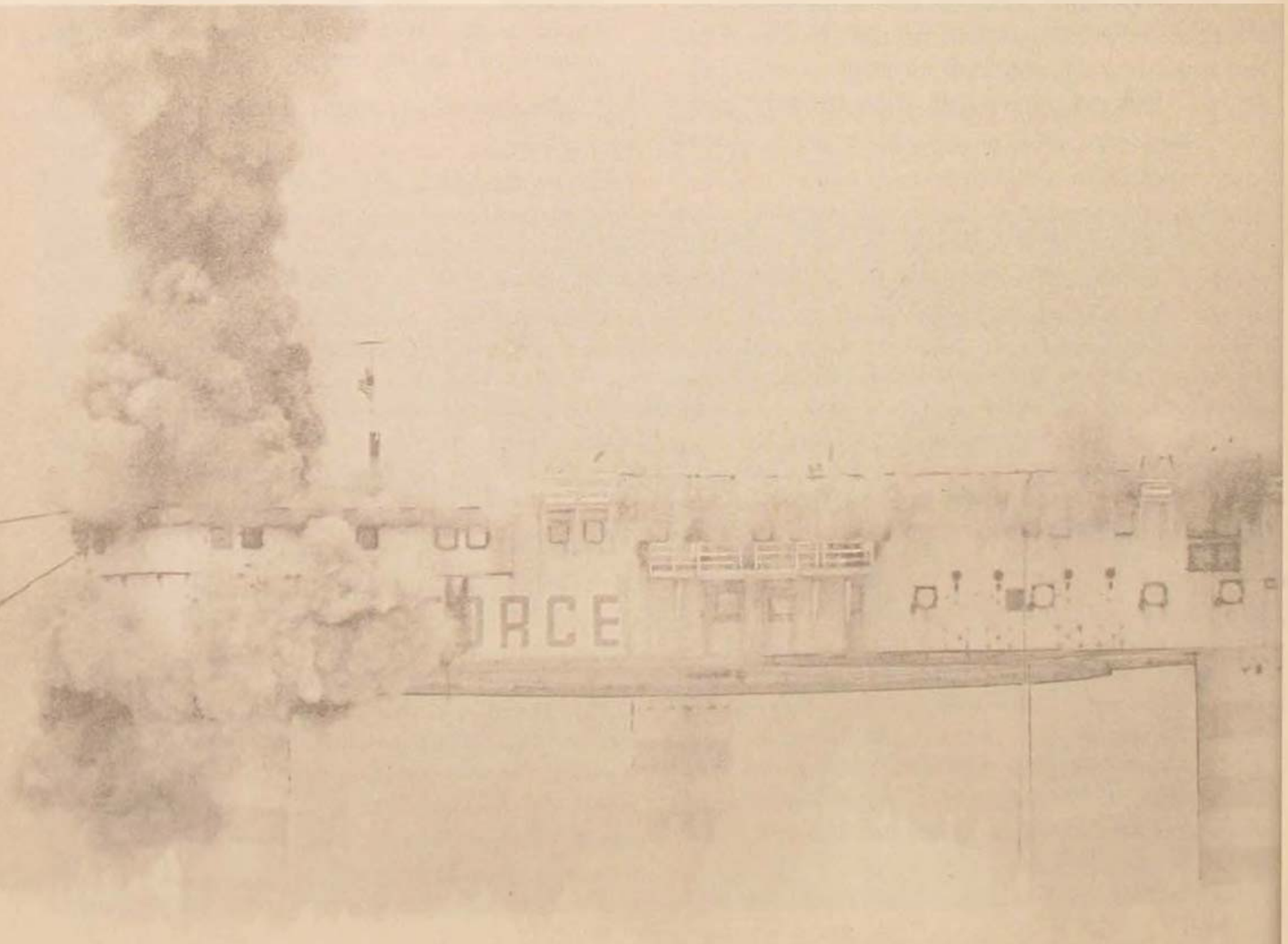
**He communicates effectively and works efficiently with people at all levels and from all walks of life. He participates in specialized education, as well as specialized training, and he employs this continuing preparation, in conjunction with professional military education, in order to be able to assume greater responsibilities as he progresses in his military career.**

**The professional Air Force officer recognizes that he must continually expand his knowledge and understanding of the art of war. He recognizes his responsibilities to the Nation, and he thus seeks to maintain those high intellectual, ethical and physical standards requisite to a corps of professional officers which merits the trust and respect of the society from which it draws its authority and which it is duty-bound to defend.**

Extract from the AFERB Report on Professional Military Education, Volume 1, 10 July 1963, as modified by Hq USAF.

# LAST OF THE TEXAS TOWERS

*Tow lines attached, tugs prepare to move away from Texas Tower No. 3 prior to the blasting of its legs. The explosive blast (below) demolishes the structure's left leg. It was blasted a split second before the others to "launch" the structure into the ocean at a slight angle.*



*A helicopter lands crewmen on the 1600-ton structure as it is towed to Kearny, New Jersey. Its lower deck is welded shut and filled with urethane foam for flotation.*

ON 6 AUGUST 1964 the last of the Texas Towers, Tower Number 3, was plunged into the sea by a commercial salvage firm. The giant radar stations, nicknamed for their likeness to offshore oil-drilling rigs in the Gulf of Mexico, were erected on the continental shelf off the northeast coast of the United States between 1955 and 1957, to plug gaps in the North American early-warning system. One tower collapsed during a storm in January 1961, with a loss of 28 lives. The other two functioned 24 hours a day, seven days a week, until June 1963, when the Air Force declared that long-range aircraft and other advances adequately filled the original gaps.

The towers were in the shape of equilateral triangles measuring 200 feet on each side. Supported by three tubular legs 14 feet in diameter sunk 45 feet into the ocean floor, the towers rose 87 feet above the water. The legs, each with 2½ feet of concrete between outer and inner steel tubes, were utilitarian: two were containers for fuel oil and one for seawater to be distilled for drinking purposes. The evaporators were capable of making four gallons of fresh water per minute, and an 82,000-gallon tank ensured an ample supply.

The towers were divided into four main decks. The bottom one was mainly used for utilities; the second was living quarters; the third was an operations area; and the top one contained the radar domes. Originally the towers were manned by 105 men, but automation eventually reduced the requirement to 65. They usually served 30 days aboard a tower and then 30 days on shore duty. Helicopters and ships maintained contact with the towers. Ample electronic equipment assured the men of rapid communication with Air Defense Command installations.

After the towers were declared surplus, an attempt was made to salvage Tower Number 2, located 153 miles off of Cape Cod, Massachusetts, by blasting the legs, but it sank when it hit the ocean. Tower Number 3, positioned 30 miles southeast of Nantucket Island, Massachusetts, was blasted from its moorings and salvaged by the Lipsett Division of Luria Bros. & Co., Inc., both subsidiaries of the Ogden Corporation, under supervision of the U.S. Army Corps of Engineers. Lipsett previously had dismantled the French liners *Normandie* and *Liberté*, the battleships *New Mexico*, *Iowa*, and *Wyoming*, and the aircraft carrier *Enterprise*, but there were some unique problems in this project.

Prior to the salvage operation AF Ground Electronics Engineering-Installation Agency crews dismantled the electronic gear and other equipment amounting to 800 tons.

To prevent the tower from sinking, the lower deck was filled with a special lightweight urethane foam, applied by the Poly Systems Division of Dayco Corporation. This foam, formulated from basic resin and isocyanate materials, increased forty times in volume to fill the space, adhered to the surface, and set in minutes to a high-strength, moisture and fire resistant, rigid mass.

When the foaming operation was completed, acetylene torches partially cut the legs 3 or 4 feet below the platform, explosives were set on each leg, and heavy charges were planted inside the legs below the ocean floor. The explosive charge on one leg was detonated a half-second before the other two, to cause the platform to tilt as it dropped to the water. Oceangoing tugs had lines already attached and towed it to Kearny, New Jersey. The salvage firm may convert it into a floating dock equipped with a machine shop or may strip it of the steel for scrap metal. In the latter event the urethane foam will be sold for flotation material.

# Books and Ideas

## TUNNER AND THE SAGA OF AIRLIFT

Colonel Raymond L. Towne

"If General Tunner were running the lion-taming act for Barnum and Bailey, the lion would put his head in Tunner's mouth—so watch out."

This description was confided to me by a freshly scarred colonel that day in 1946 when I reported for duty in Tunner's Memphis headquarters: Continental Division, Air Transport Command.

By this time Brigadier General Bill Tunner had already completed four years in the mass airlift business. Behind him were the successful wartime Ferrying Division and India-China "Hump" airlift operations. Ahead of him lay Berlin, Korea, Lebanon, Formosa, Big Slam, and a host of smaller but equally intense emergency airlift operations.

But even by 1946 the Tunner legend had crystallized around a man described as hard-driving, coldly brilliant, and known for the unusually penetrating quality of his displeasure.

The jacket of his absorbing book, *Over the Hump,** describes him as "the Man Who Moved Anything Anywhere, Anytime."

Both descriptions are incomplete.

In the years following the colonel's warning, Tunner moved many of us physically all over the globe. He also moved us emotionally: from cold rage, through sheer exhaustion, to the peaks of quiet pride in having hacked another "impossible" job.

What was General William Henry Tunner really like—and how did he do what he did?

How did he save Berlin from the Soviet strangle?

How did he move four Chinese armies over the Himalayas when Hannibal couldn't move one winning army over the Alps?

How did he keep the U.S. Eighth Army going

***William H. Tunner, Lt. Gen., USAF (Ret), *Over the Hump* (New York: Duell, Sloan and Pearce, 1964, $6.95), 332 pp. plus index.**

with rations, gasoline, and ammunition in Korea when there were no roads or rails and shipping was out of reach?

How did he inspire men who cursed his eyeballs on the Hump operation—and flocked to his command when the Berlin Airlift began? And then did it all over again when the Korean Airlift began to form.

How did he do it? On balance, I believe he knew his mission better than any man in his command, and he knew his men better than they knew themselves. For the professional officer and noncom this is the most compelling lesson of *Over the Hump*; and this is the lesson which must have inspired General Lucius Clay's urging every military man to read the book.

*Item.* Tunner would not sit through a briefing that did not begin with a statement of the mission. ("Don't tell me what you've got—tell me what you're here for.")

*Item.* Tunner would not sit in his office, or any subordinate commander's office, if he could be out flying with his men, or listening to their gripes, or looking around to see what cartoons or slogans they had pinned up on their walls. ("Let's get out and see what the boys have got on their minds today.")

*Item.* Tunner was the most avid pin-up fan in the Air Force. No, not for photographs of polka-dot bikinis. Tunner liked the one Captain Martin Luther tacked up in the Flight Operations Center one rainy night. This was after Luther had been told that he would have to work a double shift before he flew his daily load of coal into Berlin. The pin-up was a plain piece of paper on which Luther had neatly lettered: "Tons for Tunner: If you don't have a double hernia—you're not pulling your share of the load!"

When the General saw the embarrassed Luther's handiwork, he merely smiled and asked him how the operation was going. Tunner knew his man. He knew that Captain Luther might moan and groan. He also knew that Luther would rather suffer the double hernia than let the mission down.

*Item.* Sergeant Jake Schuffert was ordered to cartoon the hardships, discomforts, and tribulations of the men who crewed and flew the Berlin and Korean Airlifts. Naturally the base commanders complained at being "Schuffertized" when their mess halls were portrayed as serving roast camel, or as having gorillas cooking food "untouched by human hand." But it did them no good. Only the General could censor any of Jake's masterpieces. He has yet to censor the first one, except to keep Jake's "latrine humor" under control.

Since Jake's works were printed in the official headquarters daily newspaper, every coal heaver, nut twister, and airman knew that his problems were known to The Old Man even if he couldn't do anything about them immediately.

If leadership begins with knowing your men, then *Over the Hump* is filled with such lessons. It is filled too with Tunner's incisive "cause and effect" logic—the logic of a man who, even in the heat of World War II, viewed his airlift mission not in static relation to organization charts or tables of equipment but as one of the dynamic forces soon to reshape our postwar world.

Certainly by 1947 he saw the postwar world with a clarity of mind that, unfortunate when it happened, at times exceeded that of his superiors.

"Are we to become the Roman Empire of the Twentieth Century? Are we Americans, together with our allies, going to be forced to man the frontiers of the free world against the Communist 'Huns and Vandals'?"

He posed these questions to me one afternoon at our Fort Totten headquarters of ATC's Atlantic Division. By 1947 the hot war had been over less than two years. But already chill winds were blowing off the steppes and Tunner was trying to sense what this would mean to all Americans, and particularly to their military services.

"If this is to be our future," Tunner continued, "then we are going to need airlift forces of a size and capability we can't conceive of today. How else can one nation lead its allies in policing the world except through a superior technology that will give our military forces unquestioned flexibility and mobility?"

Was he right? The answers in *Over the Hump* —and your daily newspaper—are abundant.

It would be difficult for any military man to put this book down unfinished. Regardless of his assignment, airlift today touches the life of every man who wears the Navy's blue, the Army's green, or Shade 84.

The F-104 pilot is aware that his ability to continue to fly hinges on the airlift of his engine replacements to Europe or Formosa or wherever his slice of sky may be.

Thule is no longer at the end of the world. It is now less than six hours from Broadway by MATS C-135.

The Polaris expert tending his missile under the turbulent North Atlantic knows that he and his fellow submariners will soon exchange places with a fresh crew flown in to a rendezvous by airlift.

From Arabia to Australia—and beyond to New Zealand and the ice runways of Antarctica—the comings and goings of the airlift planes are today real scenes taken from Tunner's vision.

No one will disagree with *Over the Hump* that Tunner's vision took a good many pokes in the eye over the years. Years when it was deemed necessary to deny one senior general officer the use of a transport to move his office equipment during the Korean War. (His priority was too low.)

Years when it was necessary to appeal directly to Air Force Secretary Symington for engines, spare parts, and even mechanic's wrenches to keep the Berlin Airlift going. (Let us draw the curtain of charity over the choleric effect this had on the theater commander who was charged with this support requirement.)

Years when Tunner himself must have felt the effect of seeing his immediate successors at U.S. Air Forces in Europe and at MATS put on four stars to do a job he had been doing with only three.

If *Over the Hump* should have been retitled *The Battle of the Century*, then who won?

Certainly Tunner did. Four years after retirement his services have never been in greater demand. He is on the board of directors of the leading air freight airline operating over the Atlantic. He is a consultant to the Douglas Aircraft Company on their heavy air transport programs. His advice and counsel on airlift problems are sought regularly by senior military and civilian members of the Defense establishment. The high respect for his opinions held by the Congress is reflected in the action of The Honorable L. Mendel Rivers in naming General Tunner "Mr. Airlift" following the Airlift Subcommittee hearings in 1960.

But it is far from a one-sided victory. There are other winners also.

The trooper in the green beret sloshing through Viet Nam can get what he needs from the ZI when he needs it, through airlift. Or he can get stateside medical care within 12 hours if a Viet Cong bullet cuts him down.

Another winner is the worldwide logistic system of the Air Force. Indeed, the logistic systems of all the military services are vastly more effective, at far less cost, because Tunner's principles of air-

*Arriving at Ramey AFB to observe Operation Big Slam/Puerto Pine, Secretary of the Air Force Dudley Sharp is met by Military Air Transport Service commander, Lieutenant General William H. Tunner. Operation Big Slam was the last big MATS exercise before General Tunner's retirement in 1960.*

lift economics are in general use today.

With the axiom of the nail and the horseshoe escalated into billion-dollar procurements for global-ranging forces, it is unrealistic to gallop into battle dragging your depots behind.

And if you preposition what you need at point X, how do you know that the battle won't be fought at point Y? Or so goes Tunner's premise for which he fought again and again in the hot and cold war areas of the world.

But the real winner is the reader of *Over the Hump*. He can join navigator Hal Sims in singing

> If I don't hit Ascension
> My wife will get a pension.

Or he can churn over the Naga Hills with ex-stunt pilot Andy Cannon in a balky C-46 while the headhunters below lick their chops and hone their knives.

Or join hungry Hump flier Eddie Guilbert in clamoring for "eggis and flied lice" at the local Chinese airstrip.

Or hoist a glass of Rhineland's finest with Honorary Burgomeister Robert Hogg as he postulates the bylaws of the Berlin Birdwatching and Airlift Operators' Improvement Association.

Or skim in over the "frozen Chosen" reservoir with "Red" Forman in a bullet-holed C-47 to help the embattled U.S. Marines fight their way out of a ring of Chinese bayonets.

Tunner knew his men and he knew his mission.

He demonstrates in *Over the Hump* that he also knows how to tell an exciting tale of military adventure.

*Long Beach, California*

# Contributors

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Colonel Raymond L. Towne, USAF Retired, was for four and a half years Director of Information, Military Air Transport Service, preceding his retirement on 31 May 1964. He was a bomber pilot and operations officer in North Africa and Europe during World War II. Since then he has been closely associated with airlift operations except for two years as special assistant to the USAF Surgeon General. He served as Flight Operations Officer and later organized and directed operational production control for the Berlin Airlift Task Force. During the Korean War he was Chief of Information, Far East Air Force's Combat Cargo Command. In 1953 he became Chief of Public Information and Special Projects, Headquarters United States Air Forces in Europe. He is a graduate of the Air Command and Staff College, Air Force Special Staff School for Public Relations, and the Air Force Advanced Public Relations Course, Boston University. Colonel Towne is now Director of Public Relations, Douglas Aircraft Company, Long Beach, California.

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