Chapter 6

Operational Concepts for Attacks of Follow-On Forces

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Chapter 6

Operational Concepts for Attacks of Follow-On Forces

This chapter discusses those concepts for achieving the objectives presented in chapter 5 that OTA has been able to identify as feasible and under serious consideration by the military. According to DoD, a' 'concept of operations" is defined as:

> A verbal or graphic statement, in broad outline, of a commander's assumptions or intent in regard to an operation or series of operations . . . The concept is designed to give an overall picture of the operation. It is included primarily for additional clarity of purpose. '

A concept of operations defines the requirements for systems and organizations. For that reason, a concept of operations can be used as a framework for acquisition strategies to develop, acquire, and deploy equipment (and develop procedures) to provide the needed capability:

> Only with the use of explicit concepts of operations can one provide a basis for the identification of the component parts, whether they be surveillance systems, assessment centers, control centers, delivery systems, weapons, or munitions. [2]

There are many different possible concepts of operations for FOFA, involving various weapons and attack schemes. The discussion below details several approaches for achieving the objectives discussed in chapter 5 and describes the concepts of operations for the approaches that appear feasible. The approaches require certain target acquisition and weapon capabilities, which are discussed subsequently. Some of these target acquisition and weapons needs apparently cannot be met, for reasons given below.

'*Department of Defense Dictionary of Military and Associated Terms,* Joint Chiefs of Staff, JCS Pub. 1, 1 June 1979. This document incorporates NATO STANAG 3680, "NATO Glossary of Terms and Definitions for Military Use (AAP-6)."

'Lt. Gen. Glenn A. Kent, USAF (Ret.), *Concepts of Operations: A More Coherent Framework for Defense Planning* (Washington, DC: The Rand Corp., Rand Note N-2026-AF, August 1983), pp. 11-12.

APPROACHES FOR FOFA

The categories of FOFA objectives (as defined inch. 5) depend primarily on the echelon of force to be attacked and on the range of the attack. Each objective can be achieved through one or more approaches. These different approaches–summarized in table 6-l–are outlined below in terms of the targets and kinds of attack for each approach.

Category 1—5 to 30 Kilometers

The objective of category 1 FOFA operations is the destruction of second-echelon regiments.[3] The most feasible approach to destroying these targets appears to be to attack them while they are moving on roads on their final approach to battle.[4] These regiments will be moving in battalion columns of approximately 40 to 50 vehicles, with the combat battalions in the lead. There are about eight battalion-sized column targets per regiment. In these columns the fraction of armored combat vehicles is roughly 70 percent. The support elements of the combat regiment are not likely to leave the departure area with the combat elements.

[3]As explained inch. 5, the term "second echelon" denotes both the second echelon of the initial deployment and elements of follow-on forces that are in the same range band and disposition, as the follow-on forces become deployed and engaged.

[4]Details of march considerations for Soviet units on the attack are discussed in U.S. Army Intelligence and Security Command, Soviet *Army Operations* (Arlington, VA: U.S. Army Intelligence and Threat Analysis Center, IAG-13-U-78, April 1978), pp. 3-20 through 3-31. Unit sizes and compositions were discussed in ch. 5 of this report; see in particular table 5-2.

Table 6-1: Summary of Targets and Objectives for FOFA[a]

	Range (kilometers beyond FLOT)				
Targets	**5 to** 30	30 to 80	80 to 150	150 to 350	350 to 800
Moving columns	1	1	**2**		
Units in assembly areas	1	1	**2**		
Command posts		**2**	**2**		
Chokepoints and halted units			**2**	**2**	
Units transported on roads				**2**	
Units in off-loading areas				**2**	
Units transported on rails					**3**
Rail network					**3**
Levels of damage[b]	**1 "Destroy"** **2 "Disrupt"** 3 "Delay"				

[a]This choice of objectives for FOFA operations is based on information received from SHAPE, US Army, and US Air Force sources, as discussed in ch 5. This choice of targets and objectives is for OTA analysis only, and *is not* intended to be exhaustive or definitive.
[b]See ch 5 for discussion of desired levels of damage.

SOURCE: Office of Technology Assessment, 1987

According to the Institute for Defense Analyses (IDA),[5] each column will be on the road for only about 30 to 60 minutes, and it will take the entire regiment between 1.5 and 2.1 hours to accomplish the move forward. In a single day, a corps facing a Warsaw Pact main attack may see seven such second-echelon regiments moving forward,[6] and their movements may span a total of 9 hours of the day.

The amount of time a target battalion is moving is so brief that it may not be feasible to reattack it. Therefore, individual attacks should be "sized" to destroy a battalion in one attack.

Category 2—30 to 80 Kilometers

The objective of FOFA operations in this category is the destruction of second-echelon divisions. Within this range, divisions will be moving between their division assembly areas (concentration areas) and the departure areas and then occupying the departure areas.[7]

While on the move, the division marches by regiments along two or more roads. The organization for march is illustrated in figure 6-1. Compared to category 1 attacks, a smaller fraction of the vehicles will be armored combat vehicles. Of the 55 or so battalion-sized columns in a division, about 25 will contain armored combat vehicles, and these 25 will average about 50 percent armored vehicles.[8] Overall, about 30 percent of the vehicles in a Soviet combat division are armored. In one day, a NATO corps facing a Warsaw Pact main attack will see a single division moving in this range.

This portion of the division's movement will last about 6 to 8 hours; any one battalion-sized column will take about 1.5 to 3 hours to traverse this distance. Compared to Category 1, there will be more opportunity to attack each target and perhaps opportunity to re-attack.

Another approach to destroying second-echelon divisions is to attack their component regiments in their assembly areas.[9] These areas will be occupied for at least several hours, while the units perform final preparations for battle (including maintenance, supply, and rest). Although the term "assembly area" may give an impression of a concentrated target set, in fact the clusters of vehicles maybe rather dis-

[5]Institute for Defense Analysis, "Follow-On Forces Attack, Volume II: Reconnaissance, Surveillance, and Target Acquisition (RSTA) Architecture To Support FOFA, " IDA Report R-302.

[6]Ibid., pp. II-4 through 11-10. The number of regiments moving per day is derived assuming that the corps faces an initial deployment of three first-echelon divisions plus one follow-on division entering the battle in 24 hours.

[7]For more detail, see vol. 2, app. 6-A, note 2.

[8]*See* ch. 5 for further details, especially table 5-1.

[9]See vol. 2, app. 6-A, note 4 for details.

Photo credit U S Department of Defense

Tanks traveling on West German Autobahn.

persed in a large area. Further, units are likely to take every possible advantage of cover and concealment; wooded areas and urban areas are preferred. However, there may not be enough areas with good cover available to meet the needs of all the units moving through, and those areas that are used may not provide good cover after a few days of combat.

Category 3—80 to 150 Kilometers

At this range, the objective of attacking follow-on forces is limited to disruption. In addition to the types of attacks discussed above, other approaches are also under consideration.

Second-echelon divisions can be attacked directly while they move in this range, and perhaps while in assembly areas. [10] They move on roads, with the tracked vehicles either on transporters ("low-boys' or moving under their own power. Although the moving targets are predominantly the same as in the previous categories, armored combat vehicles on transporters are "cold" (engines off and cool) rather than "hot" (engines on and emitting hot exhaust).[11]

Two other approaches to disrupting second-echelon divisions (and first-echelon armies) are often advanced. In the first, "chokepoints" are created in front of moving Warsaw Pact units, and the units are subsequently attacked while they are halted trying to clear the chokepoint. The other approach is to attack command posts. The classic concept for chokepoint attack is to destroy bridges across a major river just prior to the arrival of an enemy unit. In this range, the Elbe, Saale, and Vltava rivers provide a major north-south barrier. Other possible chokepoints include narrow roads through towns or natural defiles, tunnels, and dikes. The advantage of this approach is that the target division will be halted at the chokepoints, simplifying the problem of target location because targets will not be moving. Further, the density of vehicles (and personnel) will be greater than for either moving units or assembly areas, making area munitions more destructive.

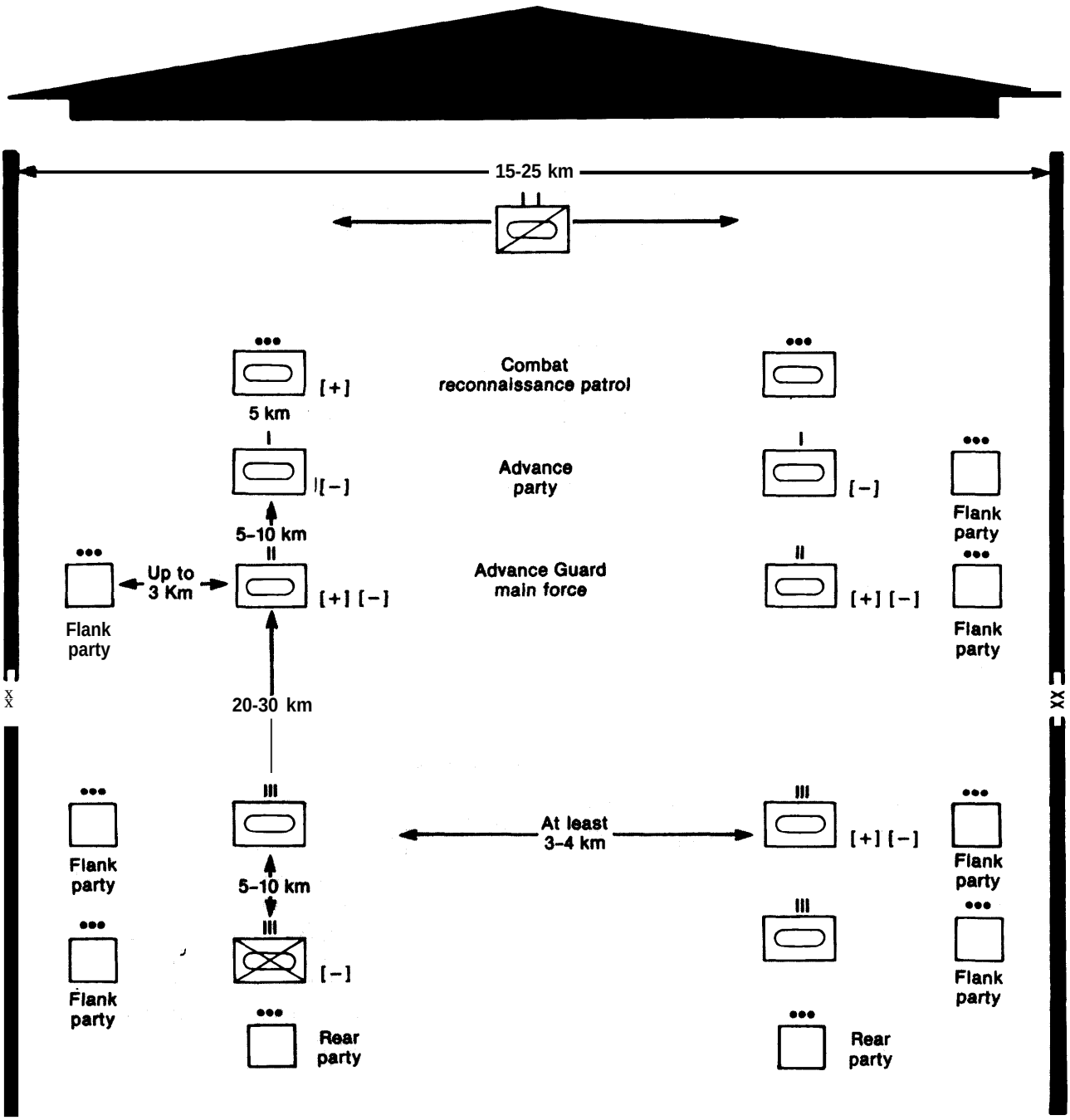
A recent major study considered destruction of the bridges over the Elbe river for a period of up to 10 days as a means for creating a barrier that would delay the introduction of follow-on forces into the battle. The expected impact of these attacks was unclear, and the effort needed to enforce an effective barrier was seen as being potentially very large.[12] This is because the ability of the Warsaw Pact to repair roads and bridges is often quite high, and the Warsaw Pact forces are thought to have large

[10] See vol. 2, app. 6-A, note 5 for further detail.

[11] Whether engines are cold or hot is important to certain kinds of smart anti-armor munitions, because some detect and engage warm targets by the infrared energy they emit. See ch. 11 for further discussion.

[12] Institute for Defense Analysis, "Follow-On Forces Attack, Volume I: Summary, " IDA Report R-302.

Figure 6-1 .—Typical March Formation, Soviet Tank Division



SOURCE: U.S Army Intelligence and Security Command, *Soviet Army Operations* (Arlington, VA: U.S Intelligence and Threat Analysis Center, IAG-13-U-78, April 1978), pp 3-24

quantities of mobile tactical bridging equipment and stockpiles of temporary bridges at prepared crossing sites. Attacking road bridges may have the same problems, and the dense network of roads in central Europe may often offer alternative routes.

The other approach to disrupting second-echelon divisions (and first-echelon armies) is to attack their command posts. '3 It is likely that a command post can be destroyed if its location is known, but the effect on combat effectiveness of destroying the command post is not clear.[14] Further, the Soviet practice is to have several command posts available at division and army levels, typically a main post, an alternate, and a rear.[15] Thus, it is difficult to predict the effect of destroying one or more command posts in the division.

Category 4—150 to 350 Kilometers

The objective here is to disrupt and delay second-echelon armies. General approaches are attacking units moving on roads, and creating chokepoints and barriers to their further movement forward.

[14]See vol. 2, app. 6-A, note 8 concerning CP locations and dwell times.

"This relates to the question of tactical flexibility (and rigidity) of Soviet forces, which is discussed in ch. 4.

[15]While moving, there may be additional CPs (e.g., forward). Also, other division command and control centers such as the artillery fire control group might assume the CP function, if necessary.

Photo credit: U.S. Department of Defense

Tanks on transporters.

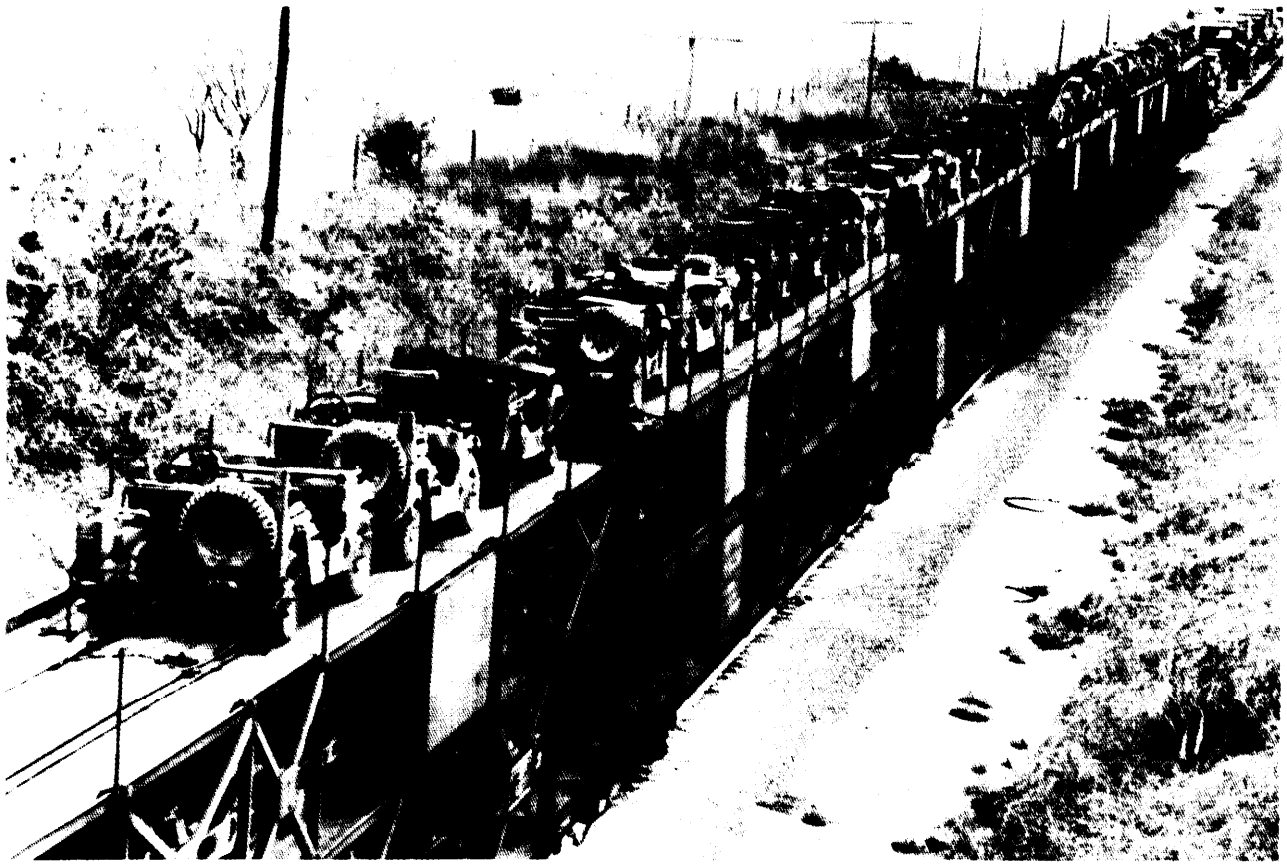


Photo credit U S Department of Defense

Military unit transported by rail.

Divisions of the second-echelon armies will move toward this region from the east on rail, and move onto roads at off-loading areas (OLAs) in this region. From that point they will move forward on roads, with the armored vehicles either on transporters or moving under their own power. The possible targets for direct attack include trucks and armored vehicles in the OLAs, trucks moving forward with armored vehicles on transporters (' 'cold" tanks), and armored vehicles moving under their own power ("hot "). Divisions will be moving with their full combat services support and rear support complement.

Chokepoint attack could take advantage of the Oder and Neisse rivers by attacking road bridges over these rivers. Also, the units halted behind dropped bridges could be attacked directly.[16] For this approach to be effective the bridges must be attacked just as or before the enemy division uses them, and the subsequent attack of forces would have to follow closely. Due to the Warsaw Pact capability to rebuild or replace road bridges, the rivers would have to be under surveillance every 12 to 24 hours to discover new bridges. Pontoon bridges just below the river surface would present a particular problem for surveillance systems.

Category 5—350 to 800 Kilometers

In this deepest region, the objectives of FOFA operations are to delay the second-echelon fronts during the 10 to 20 days after D-day in which the fronts mobilize and move

[16] See vol. 2, app. 6-A, note 9 for additional details.

forward.[17] These units originate in the Soviet Union, and are transported by rail from garrison areas to the theater of battle. Attacks to delay this movement can be targeted against the units themselves, or against the rail transportation system being used.

There are a number of rail bridges across the Vistula river that could be attacked to delay movement. These would also be more difficult to repair than most road bridges, due to the alignment necessary for rail repair and the loads that must be carried by the repaired bridge. Reattack of bridges after 10 to 15 days would allow repairs to be monitored and new bridges identified and targeted. Also, elements of the rail network itself could be attacked with mines that would damage the rails and disable trains when they approached. Because the train would be derailed, a delay of 18 to 24 hours could be expected before the rail line would be clear. [18] The routes for repair trains would themselves be mined, further aggravating the delay. The use of such mines and rail bridge attack could impose substantial delays on rail movements.

Attacks against units on trains in Eastern Europe would be aimed at causing sufficient damage to delay the unit by at least several days. Attacks would be repeated every 3 to 4 days.

As the component Soviet divisions cross from the Soviet Union into Poland and Czechoslovakia, because of the rail gauge change, "transloading" must take place between trains. There are a number of transloading zones at the Soviet border, comprising many yards,[19] whose destruction would inhibit this movement, and which could provide especially valuable targets if attacked while occupied. Other high-value infrastructure targets include the power stations in Poland that provide electricity to the rail system, and the (relatively few) control stations that schedule and coordinate rail movement.

[17] If the Warsaw Pact has a sufficiently long mobilization period prior to war these units may have already moved forward, and this approach could not be effective.

[18] The use of mines against vehicles on roads is not expected to be as effective in damaging forces or delaying movements, due to the substantial mine-clearing equipment of Warsaw Pact forces and the flexibility of road vehicles for bypassing mine areas.

[19] See vol. 2, app. 6-A, note 10 for details.

FUNCTIONAL NEEDS

Several functions must be accomplished in order to implement these approaches, including:

- suppression of enemy air defenses,
- surveillance and reconnaissance,
- situation assessment,
- target acquisition,
- attack control,
- weapon delivery, and
- target kill.

Because some of these tasks are quite difficult to accomplish under longer range conditions, they illustrate the advantages and disadvantages of the approaches discussed above.

Suppression of Enemy Air Defenses

In order to find or attack follow-on forces and survive, NATO tactical aircraft must be supported by effective suppression of enemy air defenses (SEAD). Warsaw Pact air defenses are formidable, particularly in target areas. The use of stand-off weapons could reduce or eliminate attrition of weapon delivery aircraft in the target area, but not en route to the target areas.

Surveillance and Reconnaissance

Surveillance is the routine collection of information for situation assessment, target acqui-

sition, attack control, or cueing of reconnaissance systems. Reconnaissance is the collection of information about specific areas of high interest for situation assessment, target acquisition, or attack control. Either maybe performed by manned or unmanned aircraft equipped with stand-off sensors, by ground-based sensors, by ground forces penetrating enemy territory, and by other means. Most proposals for enhancing Allied Command Europe's (ACE 's) FOFA capability will require current surveillance and reconnaissance capabilities to be enhanced.

A number of systems now in development could contribute to NATO's capability to find and track follow-on units; some are already providing limited operational capabilities. Electronics intelligence (ELINT) sensors such as SENIOR RUBY, TEREC, and PLSS[20] could locate air defense radars.[21] Communications intelligence (COMINT) sensors such as SENIOR SPEAR and GUARDRAIL can monitor radio traffic used to control unit movements. Imagery intelligence (IMINT) sensors such as ASARS-II and AQUILA[22] could provide radar and electro-optical imagery of vehicle clusters stopped in assembly areas. And moving target indication (MTI) radar, such as Joint STARS,[23] could detect vehicle motion and measure vehicle velocity, thereby providing a form of measurement and signature intelligence (MASINT).

Situation Assessment

Fusion (i.e., correlation) of data of several disciplines (e.g., ELINT, COMINT, IMINT, and MTI MASINT) may be required to reliably recognize, track, and count follow-on units. For example, fusion of MTI MASINT and IMINT can help distinguish moving combat units from other traffic.[24] Analysis of the data is required to infer enemy activities and intentions for reliable situation assessment. Failure to fully implement all the enhancements identified by SHAPE[25] would limit, but not eliminate, ACE capability for situation assessment in the 1990s. That is, while all of these systems are desirable and would be useful, the lack or loss of any one of them would not be catastrophic.

Target Acquisition

Additional data beyond that required to detect or recognize a unit is required to "acquire" it as a target-i. e., to locate it with sufficient accuracy and timeliness to attack it effectively. The accuracy required for targeting will depend on target type and disposition (e.g., moving or stopped) and on the types of munitions, weapons, and weapon platforms available for use.

Stationary Targets

Acquiring stationary targets in assembly areas requires some form of high-resolution imagery, such as can be provided by electro-optical, forward-looking infrared, or film cameras, by infrared line scanners, or by synthetic-aperture radar. This information must be available to the attacking weapon when the vehicles are stationary. Targets in assembly areas are expected to dwell there several hours, so timeliness of target location data does not appear to be a critical problem in this case. COMINT data will not usually be sufficient for attack of enemy combat units, because a unit may use communications antennas several kilometers away from itself.

[20] SENIOR RUBY and TEREC are operational systems; PLSS is in development. See ch. 10 for details.

[21] The units could depend on the area air defense radar network for long-range coverage and tactical warning of attack by NATO tactical aircraft.

[22] ASARS I I is in production, with a limited operational capability already fielded; AQUILA is in development. See ch. 10 for details.

[23] Joint STARS is in development; see ch. 10 for details.

[24] "Interspersed throughout the Warsaw Pact rear will be a great deal of military traffic, mostly trucks, re-supplying and otherwise supporting engaged and forward units. Armored elements are expected to comprise only about 10 to 14 percent of military traffic in this area, and an even smaller percentage of total (including civil) traffic.—*Model of Vehicle Activity in the Warsaw Pact Tactical Rear During a Conventional A ttack Against NATO* (Santa Monica, CA: The Rand Corp., Rand Note N-1 495-AF, September 1980).

[25] See vol. 2, app. 6-A, note 11 for details.

Moving Targets

An attack on moving combat units requires timeliness on the part of the attacker. Real-time radar coverage could be provided by airborne MTI radar or by electro-optical or forward-looking infrared cameras on unmanned aerial vehicles. Automated data communications systems could provide the links necessary for timely transmission of target location data to the weapons platform. For attacks by tactical aircraft, the target motion during the aircraft's flight must be taken into account, so it may be useful to provide updated target location information to the aircraft. It may also be desirable to provide an in-flight update to an attacking missile, although the missile's flight time is much shorter than that of aircraft.

As an alternative, target acquisition could be provided by systems on board the weapon platform itself. For example, target acquisition radar on board attacking tactical aircraft could provide the final target location data to the weapon launched from the aircraft. This approach has the disadvantage of exposing the attacking aircraft to the target air defenses for the extra time it takes to acquire the target, but allows the attacking platform to operate independently of a separate target acquisition system.

Special Targets

Target locations for permanent bridges can be determined in peacetime. In wartime, temporary bridges may be built to augment these, and damaged bridges will probably be repaired requiring reconnaissance to determine when they are again active. Information on temporary and repaired bridges might be obtained from imagery.

Command posts (CPs) maybe very difficult to detect and identify; there is no known routine, reliable means for targeting them.[26] They are primarily known by their communications (and other) emissions, but these radiate from antennas that may be some distance from the CP itself." The vehicles in a CP are not individually distinguishable from many others in a division, although it is sometimes argued that the vehicles of a CP deploy in unique and identifiable patterns, allowing their location by careful analysis of imagery .28

Deep Targets

Reconnaissance systems held at the national level primarily for strategic reconnaissance missions might be made available to the theater commander, who could task them to support reconnaissance, surveillance, and acquisition (RSTA) needs. These capabilities, if made a sufficiently high priority relative to other missions, could provide a great deal of information about movement in the enemy's rear. In particular, this information could provide cues to general movement activity in given areas, enough to task attack assets which would then acquire targets autonomously. Also, attacks into the two deeper bands could destroy infrastructure targets that support movement but are not moving themselves. Although it may be possible to attack combat units deep in the enemy rear on occasion, these national capabilities are not likely to be able to support an overall FOFA strategy based on this approach.

There is no known system that would provide imagery surveillance of the possible offloading areas (OLAs) with sufficient timeliness to support attacks while they are occupied. Although such an arrangement could be imagined, it is not likely to be an efficient use of national assets to attempt to "catch' enemy units in OLAs. The RSTA needs for this approach are thus apparently prohibitive.

Similarly, creating a chokepoint followed by attack of halted units can be dropped from consideration at this range. Warsaw Pact road bridge repair and replacement capability is sufficient to require reconnaissance of a river every 12 to 24 hours, in order to maintain a barrier. This timeliness is not likely to be met by the national level sensors available. The creation of a barrier for a specific unit, and its

[26] See vol. 2, app. 6-A, note 12 for further discussion.
"See Institute for Defense Analysis, '*Follow-On Forces Attack, Volume I: Summary, " IDA Report R-302, Draft Final, April 1986, p. ES-35.

[28] Examples of command post data are given in "Interdiction Target Set for Analysis, " draft, BDM Corp., BDM W-84-0145-TR.

subsequent attack, is likely to be even less feasible.

The Warsaw Pact rail transportation system could be attacked to delay the movement of Soviet armies, by destroying bridges and mining segments of railroad. Targeting can be accomplished in peacetime. The Warsaw Pact has substantial capability to repair damage, and some revisit of the destroyed rail bridges is necessary to maintain the barrier they provide. Revisit within 5 to 10 days is likely to be sufficient,[29] and national reconnaissance systems are likely to be capable of this mission.

Warsaw Pact units moving through the transportation system can be attacked directly. In this case target acquisition may be provided by systems onboard the platform (aircraft) or the weapon (missile) itself. Such an approach depends on there being a high density of targets, so that each attacking platform or weapon has a high probability of acquiring a target.

Attack Control

Some form of command and control support system is needed to coordinate and control attacks within, between, and across NATO command echelons. For those attacks against targets within the Fire Support Coordination Line (FSCL), close coordination between ground- and air-based attack assets is necessary to ensure coverage of targets without duplication of effort and to avoid damaging NATO aircraft. If a ground-based capability to attack beyond the FSCL is developed, similar coordination will be necessary at greater range.

Many operational concepts also require new attack control capabilities. NATO forces must accomplish quickly the processes of assigning targets to weapons and of providing final target location updates to platforms in order to support attack of moving targets.

[29]Note that the time to repair a rail bridge is substantially longer than the time to repair a road bridge, due to the alignment necessary for the rails and the larger weight of loaded rail cars that the bridge must support.

Weapon Delivery

The term “platforms,” the systems that deliver weapons, includes bombers, some fighters, and transporter-erector-launcher vehicles for ground-based missiles. Free-fall bombs must be released near their targets; glide bombs may be released at a short stand-off range; air-launched missiles may be launched from a greater stand-off. All these require aircraft as weapon delivery platforms. Ground-launched missiles need only be delivered to a launch site and launched.

Target Kill

Killing targets requires weapons, which contain munitions and, in some cases, guidance systems.

Anti-Armor Munitions

Certain munitions embodying “emerging technologies” show promise of much higher lethalities against heavily armored vehicles than current-generation munitions provide. Two such technologies are self-forging fragment technology, which is used in sensor fuzed munitions such as Skeet, and terminally guided shaped-charge technology, which is used in munitions such as the Terminally Guided Warhead (TGW) for the Multiple Launch Rocket System (MLRS).[30] Munitions of either type can be packed as submunitions into dispensers on air-delivered weapons or ground-launched missiles or artillery rounds,[31] each of which might kill several armored vehicles.

Other technologies go along with the advanced kill mechanisms to provide multiple armor kills per weapon. These include dispenser technology, or ways of dispersing submunitions in a controlled fashion such that they give optimal engagement of vehicles in the “footprint” of the weapon. Also important is the sensor technology that makes the submunition “smart,” or able to detect and follow moving target vehicles.

[30]*See* ch. 11 for further discussion.

[31]Specific munitions and submunitions programs are geared to specific platforms, however.

Weapon Guidance

Ground-launched weapons with dispenser, sensors, and effective submunitions can produce multiple armor kills only if guided (or delivered) with sufficient accuracy to the target location. Even with highly accurate target location data, lack of weapon delivery accuracy can render these weapons ineffective. Missiles must have accurate guidance in order to engage targets at ranges of 100 to 200 kilometers or more. Various guidance technologies are applicable to this problem, including fiber-optic gyroscopes for inertial navigation and miniature Global Positioning System (GPS) receivers for navigation via satellite.

Tactical aircraft can launch weapons at a "stand-off" distance from the target, staying far enough away to avoid the air defenses in the immediate target area, about 20 to 30 kilometers for Soviet regiments and divisions.[32] In this case the weapon must have a propulsion system to get it to the target, as well as a guidance system to keep it on course.

For attacks beyond the range of the theater bombers (Buccaneer, F-1 11, and Tornado), long-range cruise missiles, if developed, could be used. For attacks of rail bridges, an electro-optical scene correlator (such as presently used by Tomahawk missiles) could guide the weapon to the target area, and a laser radar could provide final guidance to achieve the necessary accuracy. For mining rail segments, the missile could use either present terrain comparison (TERCOM) guidance or GPS, coupled with some type of infrared or millimeter wave sensor for detecting the rail lines. For attacks of trains on railroads, a cruise missile would need a capability to navigate to the neighborhood of the rail line, recognize the railroad, and then fly along the rails until it detected a train.[33]

[32]The primary division air defense units are the SA-6, with a nominal range of 30 kilometers, and the SA-8, with a nominal range of 12 kilometers; see U.S. Department of Defense, Soviet *Military Power* (Washington, DC: U.S. Government Printing Office, 5th cd., March 1986). Countermeasures can reduce these effective ranges.

[33]Since the tactical vehicles would be on rail cars and "cold," and perhaps not loaded with ammunition and fuel, munitions that would damage the trucks, personnel, and perhaps light armor may give the greatest effectiveness to such attacks.

OPERATIONAL ISSUES

Sifting through the advantages and disadvantages of different operational concepts is a complex task. There are many different options for constructing operations concepts, with different target types, target dispositions, attack objectives, platforms and weapons, target acquisition systems, and ranges. Table 6-2 lists the various options in each of these areas. The relative advantages and disadvantages of all of these options are discussed below, by way of introduction to those operational concepts that appear to be feasible and that have been determined by OTA to have some serious support in military circles.

Target Type

Tanks present the greatest threat to NATO because of their combination of mobility and firepower, and the emphasis in Soviet military thought on attack with heavy armor." From this perspective they are high-value targets. However, tanks are specifically designed to be highly survivable and resistant to damage.

Light armor includes the other armored combat vehicles, such as armored fighting vehicles, armored personnel carriers, and self-propelled artillery. These pose a substantial threat because they have combat capability.

Trucks contain supplies (primarily ammunition and fuel, which are the most critical supplies for combat capability) and some personnel, and specific support capabilities (e.g., engineer, maintenance, and repair). These are the easiest vehicles to damage because they are not armored, but the damage does not im-

[34] *See* ch. 4

Table 6-2.—Options for FOFA Operations

Target type	tanks, light armor, trucks, selected high-value units, bridges.
Target disposition	fixed, sitting, moving on transporters, moving under own power.
Platform and weapon	artillery, direct attack aircraft, ground-launched ballistic missile, tactical aircraft with short-range standoff weapon, long-range cruise missile (air- or ground-launched).
Target acquisition	on-board systems, external systems.
Range	close-in (5 to 30 km), intermediate (30 to 150 km), long (150 to 800 km).

SOURCE Off Ice of Technology Assessment, 1987.

mediately affect combat capability and may not be felt for several days.

Selected high-value units include command posts (CPs) and surface-to-surface missile (SSM) units.[35] These units, when they can be found, are (usually) priority targets, but it is very difficult to locate and target them. The impact of destroying a CP is not clear. On one hand, the rigidity of Soviet command and control suggests that the unit would be unlikely to exert the initiative of going forward without strong command; on the other hand, the reliance on extensive pre-planning of operations using routine drill procedures suggests a tendency to carry the operation forward without the need for further command decisions.

Different target vehicles require different munitions. Anti-tank munitions may have little capability to kill trucks, because the infrared and millimeter wave signatures (for the engagement sensor to detect) are different for trucks and for tanks, and single holes in trucks are often repairable fairly quickly.[36] "Anti-personnel anti-materiel" (APAM or "dual purpose") munitions are good at putting lots of holes in trucks (primarily tires and radiators) that require more time to repair, but do not damage tanks. Lightly armored vehicles are an intermediate case, somewhat vulnerable to both types of munitions. Bridges usually can be destroyed only by large unitary warheads that are accurately delivered.

Target Disposition

Fixed targets such as bridges generally can be located in peacetime with high precision. Target location errors are low, allowing high weapons effectiveness. However, for the same reasons, these types of targets are hardened, proliferated, or both. For example, temporary bridges and repair segments are stockpiled, and organic repair and tactical bridging capabilities are high in Soviet units.

Sitting targets (e.g., units in assembly areas) are mobile targets that are not moving when attacked. These targets are likely to choose a location that maximizes cover and concealment, but the number of suitable locations is limited.[37] A tree canopy or urban environment may conceal sitting targets from the sensors of smart munitions[38] and provide cover which reduces the effects of A PAM munitions by absorbing blast and fragments. On the other hand, personnel may be dismounted from and unprotected by sitting vehicles and more vulnerable than in other dispositions.

Targets on road or rail transporters are moving targets, so target location data must be updated either by the platform or weapon or provided to the platform or weapon in near-real-time.[39] High-value targets (tanks) are more clustered on transporters (especially rail) than when moving under their own power or sitting, and are arranged in regular arrays that may increase their vulnerability to attacks with particular weapons. But because the vehicles are

[35] SSM units are not necessarily follow-on forces, but they will deploy in the Warsaw Pact rear to reduce their vulnerability. SSMs are not considered in detail in this assessment.

[36] Tank kills often occur because of the spalling of armor inside the vehicle, killing personnel and setting off ammunition or fuel.

[37] See app. 6-A (vol. 2), paragraph 13 for further details.

[38] For example, see Institute for Defense Analysis, Follow-On Forces Attack, Volume III: Weapon Effectiveness and Combat Unit Effectiveness, " IDA Report R-302.

[39] 'gin this context, "near-real-time" means that the time delay between target location and weapons delivery does not reduce the accuracy of the weapon so much that its effectiveness is lost. More generally, "near-real-time" means that only electronic data processing and transmission delays are involved in data transmittal, and that no manual action is involved.

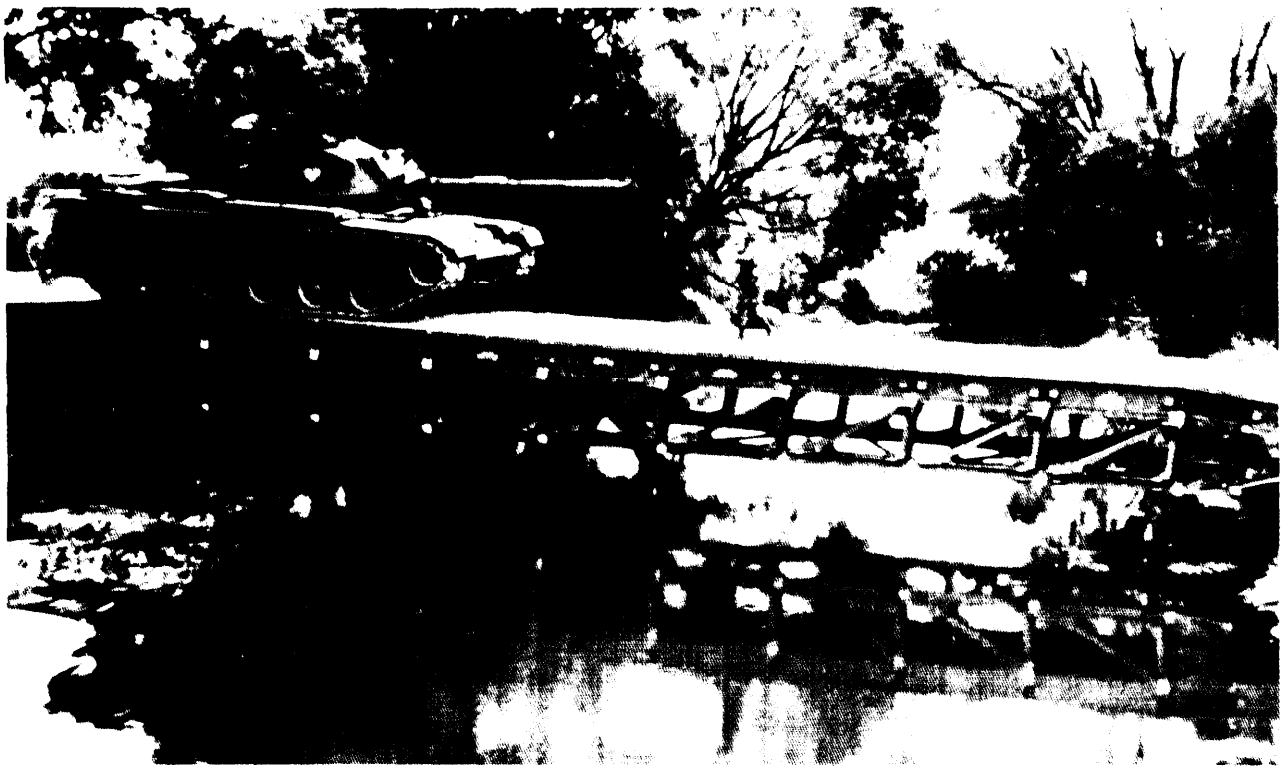


Photo credit U S Department of Defense

A portable bridge (this one is American).

not themselves operating, their signatures (especially infrared) will be different and unrecognizable by some smart weapons. Also, armored combat vehicles are probably not loaded with fuel and ammunition, and personnel are not on board, so many weapons may not have the desired effect.

Targets moving under their own power require that target location updates be provided to the weapon, either by on-board sensors or by direct link from some external sensor system, within a few minutes of attack. Armored combat vehicles are also loaded with fuel, ammunition, and crew, which increases munitions effects as does being away from cover (such as trees) that can degrade munitions effects. Finally, if NATO can make enemy movement down roads sufficiently risky that the enemy must go off-road, it will substantially delay movement forward and contribute to FOFA objectives possibly without having to attack them at all.

Platform and Weapon

Artillery now exists, and will certainly continue to be organic to all NATO divisions and corps. Both gun and rocket-launched artillery (e.g., mortars and MLRS) are available. Their range is limited to 25 to 30 kilometers beyond the FLOT. “Tube” artillery can deliver more rounds (or pounds) of ordnance per hour than can missiles or direct-attack aircraft, but has shorter range and cannot relocate quickly.

Direct attack aircraft delivery capability also presently exists and will certainly continue. The bulk of attack aircraft (F-4, F-16) are range-limited to about 150 kilometers east of the Inner German Border (IGB); the remaining aircraft (F-1 11, TORNADO, F-15E) are limited to about 350 kilometers east of IGB. Tactical aircraft (TACAIR) can concentrate firepower almost anywhere across the battle front, and relocate quickly and flexibly. But TACAIR must penetrate into enemy airspace in order

to deliver direct attack weapons, and penetration usually requires extensive support (escort fighters, electronic countermeasure pods, stand-off jammers, hunter-killer aircraft, and artillery or other suppressive fires) to reduce attrition, and attrition may still be substantial.

Ground-launched ballistic missile capability does not currently exist.[40] The expected range of the Army Tactical Missile System is 100 to 150 kilometers east of the FLOT, including a setback of the launcher behind the FLOT to increase its survivability. This range would allow some concentration of fires laterally across the front, but from any one corps probably only the adjacent corps could be supported. "Shoot and scoot tactics are required to enable good launcher survivability .41 Competing missions are not defined, except for suppression of enemy air defense (SEAD), but may evolve later.

Tactical aircraft with short-range stand-off weapons is now an option using command-guided weapons. However, after launching such a weapon (e.g., Maverick), the aircraft must remain within line-of-sight of the target while the pilot (or another crew member) guides the weapon to its target. An autonomous air-launched weapon with a range of up to 50 kilometers would allow the attacking aircraft to avoid enemy air defenses in the vicinity of the target, which are likely to be substantial. This stand-off would reduce TACAIR attrition, but penetration is still likely for many FOFA missions.

A new cruise missile or a modified version of an existing U.S. cruise missile could have a range of about 1,200 kilometers with a conventional payload of 800 to 1,000 pounds,[42] and would provide a deep delivery capability without the need for extensive air defense suppression and the risk of attrition of long-range bombers. The weapon would be launched from NATO's rear (whether from the ground or from an aircraft); the launcher would, therefore, have excellent survivability. This weapon would support rapid relocation and concentration of fire nearly any place in the theater. Because of the required range and guidance capabilities, the weapon may be very costly relative to all others, but if retired strategic cruise missiles can be modified for this mission, the cost may be much less.

Long-range conventionally armed cruise missiles, like strategic bombers used for this mission, could raise a problem of confusion in wartime. Their use in the conventional role might appear to be escalator, inducing the enemy to escalate to nuclear weapons. In addition, the development of non-nuclear cruise missiles to be launched from B-52s would raise new problems of definition and scope for certain arms control agreements. Further negotiations concerning these weapons may be necessary.

Target Acquisition

On-board systems are systems with sensors on either direct-attack aircraft, or the weapons, or both. These systems allow an attacking platform and weapon to engage targets independently of any external target acquisition system (or associated communication system), which may fail or be defeated when needed, rendering the mission ineffective. On-board systems are generally the most accurate because the target acquisition system continually tracks the target.

External systems could be used for attack by ground-launched missiles and stand-off aircraft, and could also support direct-attack aircraft. External target acquisition systems could either stand back behind the FLOT using long-range sensors, or observe the enemy from a penetrating unmanned platform. These systems support target engagement from enough distance to allow the weapons platform to avoid terminal area defenses.

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[40]The current MLRS launcher capability is planned to support this type of weapon in the Army Tactical Missile System, so launcher capability may be considered as already existing. The Lance weapon system, though it has a nominal conventional role, is not sufficiently accurate to contribute greatly to FOFA operations, and is considered a nuclear asset in this context.

[41]Given the problems perceived by NATO in attempting to target Soviet SS-21 and SS-23 launchers, these tactics are likely to achieve good survivability.

"The feasibility of a weapon of this type is discussed inch. 11.

Range

At close-in range (5 to 30 kilometers), a large proportion of the vehicles in target arrays are armored, allowing efficient destruction of the enemy's combat capability. Virtually everything that moves forward from the final assembly area is moving to combat and is a high-value target for attack. Damaging these forces is likely to have a nearly immediate effect on the battlefield. The Warsaw Pact must in general expend resources to bring its forces to the battle area, and attacking at the "last minute" means that the greatest amount of mobilization and transportation effort must be made by the enemy. Other advantages are that the widest variety of RSTA assets can "see" targets at this range with the least obscuration by terrain or vegetation, and the greatest number of weapons are available for attacks at this range (including artillery and stand-off aircraft that need not penetrate).

The primary operational disadvantage is the risk inherent in waiting to attack the enemy forces until they are just about to close with friendly forces. This approach may still allow enemy forces to concentrate with no subsequent chance to attack them before they attack. The regiments may dash forward on this final march, particularly if it is known that NATO has a very effective attack capability in this range.

Intermediate range (30 to 150 kilometers) includes targets that are still heavy in armor, though not as much so as at closer range. A major advantage is that the time and distance available in which to engage moving target units is much greater than for close-in attacks (6 to 8 hours per division v. 1.5 to 2 hours per regiment), relaxing the need for very efficient "conversion" of attack opportunities to actual attacks. A related advantage is that, for attacks to disrupt, there are several types of targets (e.g., CPs, Elbe bridges) that are not prevalent closer in. At these ranges there is still a wide variety of attack assets with sufficient range,[43] and the most powerful RSTA assets (e.g., ASARS, Joint STARS) also have coverage to this depth. However, compared to close range, attacks at these ranges are more costly.

Long-range attacks (150 to 800 kilometers deep) would hit targets that are likely to be high value and concentrated on certain transportation routes. Advantages include the fact that attacks do not need coordination with ground forces, and can force enemy units to posture their moves so as to minimize exposure to possible attack. Disadvantages of attacks at long range are both that the cost is high (in capability, attrition, or weapon cost) and that the effects on the battlefield are the most removed and hardest to predict.

[43] Only artillery drops out relative to closer-in attacks.

OPERATIONAL CONCEPTS FOR FOFA

Only a few of the many possible operational concepts will be described here, chosen so that they illustrate the primary issues without necessarily being exhaustive. These operational concepts are discussed below, in terms of generic systems and the approaches already discussed.[44]

[44] App. 12-A contains a complete list of packages embodying the operational concepts discussed above; ch. 12 discusses some of them in detail.

Artillery Attack of Regiment Columns: Category 1 (5 to 30 km)

The target regiments are probably originally located well before they occupy their final assembly areas. This location process uses several different sources of data, including COMINT and ELINT sensors and MTI radar for location cues, fusion of this data along with cartographic and intelligence preparation of the battlefield (IPB) data to identify assembly areas, and high-resolution SAR imagery for confirmation of the regimental locations.

This fused and confirmed data is sufficient to assign resources to attack the battalion columns of the regiment when they move forward.

Within this range, gun and missile artillery can deliver unguided anti-armor rounds with substantial potential destruction. A capability for artillery to effectively attack moving targets would be new, dependent on a target acquisition system capable of following the targets and a smart anti-armor round. A remotely piloted vehicle (RPV) target acquisition system that was normally dedicated to artillery use could be used for this mission. In this concept the RPV would loiter near the assembly area until the columns started moving, and then follow each column in turn (providing location data) until it was attacked successfully, at which point the RPV would find the next column. The RPV data, which could be MTI radar or E-O imagery, would be provided directly to the artillery fire-direction center. The artillery rounds may each have only a fractional probability of kill of an armored vehicle,[45] but a barrage of many (6 to 12 or more) rounds may provide multiple kills per attack.

The primary advantage of this concept is its use of widely proliferated artillery assets, allowing any NATO corps or division with the requisite target acquisition system and the appropriate ammunition to prosecute these kinds of attacks of follow-on forces. It also does not require close coordination across corps, because each corps would be attacking within its own area with organic assets. This allows a great deal of firepower to be generated. However, the primary disadvantage is closely related: the necessity for proliferating this capability across the whole front, in order to permit defense in all corps sectors. This concept would require distributing firepower, without the capability to concentrate this firepower in the critical areas.

[45]Laser-guided artillery rounds such as Copperhead, when used with an RPV (e.g., TADARS) that designates targets with a laser, may have a high kill probability against armor.

Stand-Off Air Attack of Division Columns: Category 2 (30 to 80 km)

FOFA operations at this depth would attempt to destroy enemy divisions in their movement forward on roads from division assembly areas, or destroy the regiments of the divisions in their final assembly areas.

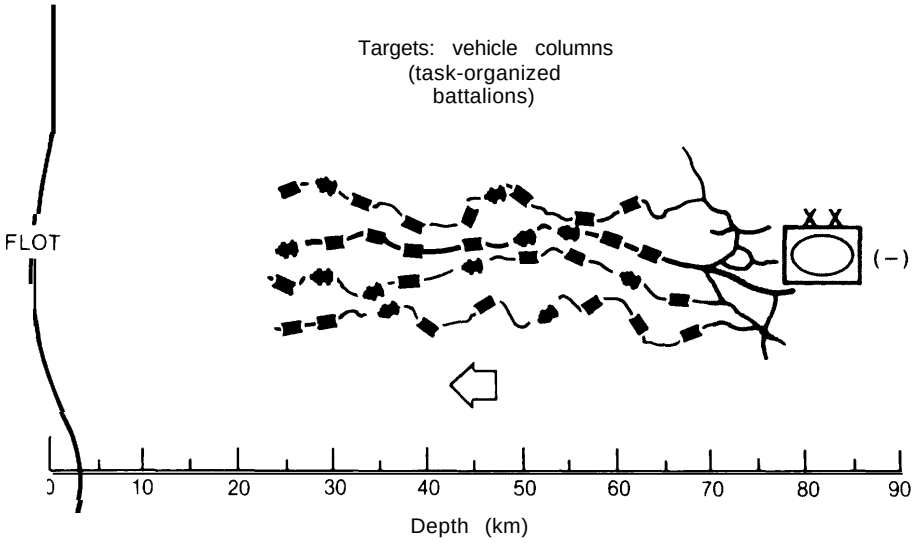
This concept employs RSTA activity cues to initiate an attack and MTI radar target acquisition data for an aircraft to deliver a short-range weapon that dispenses smart anti-armor submunitions. Anti-personnel anti-materiel munitions may also be used, in order to damage the soft and lightly armored vehicles in the division that contain personnel, ammunition, fuel (petroleum, oils, and lubricants, or POL), and other support (e.g., maintenance, communications). A data link from the target acquisition system to the aircraft would update the target location immediately prior to launch of the weapon, which would then use inertial guidance to fly the 25 to 30 kilometers to the target. This concept, illustrated in figure 6-2, would probably use penetration by a relatively large “force package” of 25 to 40 aircraft[46] in a less active area adjacent to the target area, and attack from the side, in order to minimize relative losses. The force package includes 16 to 20 attack aircraft, each delivering 2 weapons against target columns.

This concept has the advantage that the attack aircraft need not fly over the target, and each weapon may be capable of killing several armored vehicles. Indeed, the force package would be able to inflict a great deal of damage in the span of a few minutes on a large portion of a division. The primary disadvantages of this concept are that it requires penetration support, an external target acquisition system, and lengthy, centralized planning.

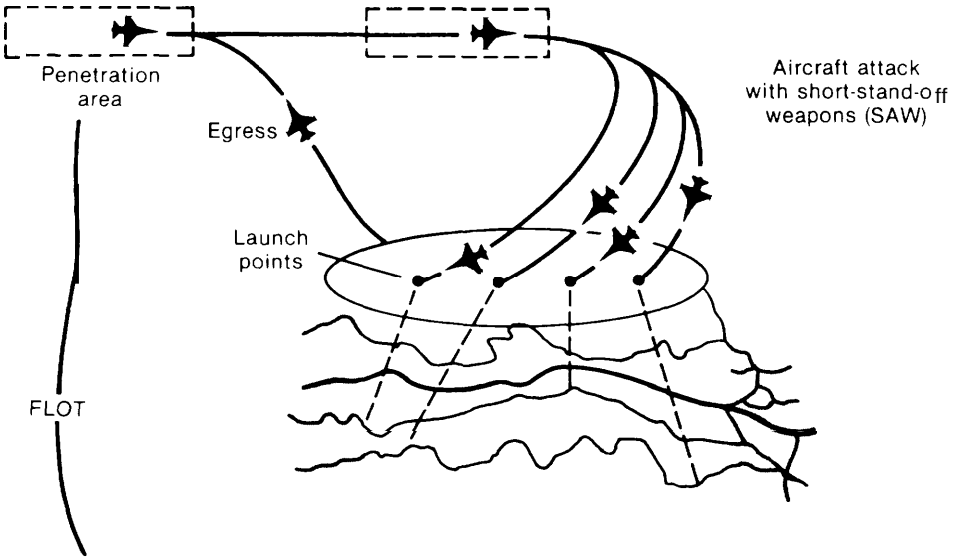
[46]As discussed in U.S. Congress, Office of Technology Assessment, *Technologies for NATO Follow-On Forces Attack Concept-Special Report, OTA-ISC-312* (Washington, DC: U.S. Government Printing Office, July 1986), pp. 81, 96-97.

Figure 6-2.—Stand-Off Air Attack of Division Columns

A. Second Echelon Division Target Set



B. Penetrating TACAIR Raid



SOURCE Institute for Defense Analyses, *Follow-On Force Attack, Volume II Reconnaissance, Surveillance, and Target Acquisition (RSTA) Architecture to Support Follow-On Force Attack,* IDA Report R-302, Draft Final April 1986, pp v-4, V-7

Missile Attack of Division Columns: Category 2 (30 to 80 km)

This concept uses ground-launched missiles to attack the same targets (moving columns of a second-echelon division), also using target location data from the target acquisition radar. This data would be updated via a fire control data system to the missile launcher just prior to launch. A setback of one-third of total range (a typical artillery rule of thumb), implies a minimum missile range of 120 kilometers. A longer range of 150 to 250 kilometers would allow coverage from adjacent corps. The

missile would use a high-quality navigation system, and deliver submunitions.

The advantages of this approach are: 1) that no separate support is needed (as it is for penetrating aircraft), 2) the long-range capability allows concentration of fires from adjacent corps, and 3) several armor kills per missile are possible. Disadvantages include the need for cross-corps coordination and the dependence on a separate system for target data.

Air Attack of Chokepoints and Halted Units: Category 3 (80 to 150 km)

Detecting and tracking unit movements is important in this concept. This process would be accomplished by the same mix of RSTA sensors and fusion capabilities used to track units for road and assembly area attacks. The chokepoint target, assumed to be a road bridge at a river or other barrier, is targeted in peacetime and can be attacked without further target location data. High-resolution synthetic aperture radar (SAR) keeps the area behind the chokepoint under surveillance, until bunching of vehicles in the area is observed. This data is reported to an attack control center, which matches targets to attacking aircraft and transmits target location data to the aircraft (which may be forming up or holding on the NATO side of the FLOT preparing to penetrate). A force package of tactical aircraft then attacks with stand-off weapons dispensing APAM munitions to damage the equipment and personnel bunched behind the chokepoint. In addition, mines may be mixed with the APAM munitions, to further disrupt the attacked units and their subsequent attempts to seek cover and repair the damage.

The advantage of this concept is that it may allow the use of munitions in a fairly open area, where they are more effective, against a target area with a high density of vehicles and exposed personnel. Also, stand-off weapons do not require overflight of the target area.

Cruise Missile Attack of Deep Rail Network: Category 5 (350 to 800 km)

Attacks at this depth will attempt to delay enemy movements of follow-on fronts.

Attacks of this type can be tasked as soon as cross-border operations are authorized by NATO. Heavy bombers would fly to the fringes of enemy territory, with minimum exposure, and launch missiles would engage their rail and bridge targets independently. Each missile would navigate to the vicinity of its target (either rail segment or bridge), recognize it, and "engage" it. For bridge attacks this would involve damaging a critical structural member. For rail segment attacks a "stick" of mines would be dispensed, that would embed themselves in the rail bed.[47]

These mines would have a delay before activation, and then actuate (all four at once) at a random time in a given period (say, 3 days). This would mean that the rail segment would suddenly (and uneventfully) become dangerous to a passing train. Were a train to come by, one or more mines would be detonated.

The advantages of this approach include the obviation of wartime target acquisition and the need to penetrate. Risks remain that enemy redeployment of air defenses would impede barrier maintenance, or that during a long mobilization Soviet fronts would deploy so far forward as to render this concept ineffective.

[47] "Perhaps four mines could be carried by each missile, comprising a stick to close one rail segment with high confidence.