APPENDIX A

ENGINEER ESTIMATE

The engineer estimate is an extension of the military decision-making process (see FMs 5-100, 5-71-3, 71-2, and 90-7). It is a logical thought process conducted by the engineer concurrently with the supported maneuver force's tactical planning process. The engineer-estimate process generates early integration of the engineer plan into the combined-arms planning process. It drives the coordination between the engineer, the supported commander, and other staff officers and the development of detailed engineer plans, orders, and annexes.

Each step of the engineer-estimate process corresponds to a step of the decision-making process. Like the decision-making process, the engineer estimate is continuously refined. Table A-1 shows the relationship between these two processes. A more detailed discussion of each step of the engineer-estimate process is found below.

RECEIVE THE MISSION

The engineer quickly focuses on several essential components of the basic order and engineer annex when he receives the mission. These components are the enemy situation, the mission paragraph, the task organization, the logistics paragraph, and the engineer annex. From these components, he determines the—

- Type of operation (offensive or defensive).
- Current intelligence picture.
- Assets available.
- Time available (estimated).

Table A-1. Relationship between the military decision-making process and the engineer estimate

Military Decision-Making Process	Engineer Estimate
Receive the mission	Receive the mission
Develop facts and assumptions	Conduct the IPB/EBA
Analyze the mission	Analyze the mission
Issue the commander's guidance	Develop the SOEO
Develop COAs	War-game and refine the engineer plan
Analyze COAs	Recommend a COA
Decide on COAs	Finalize the engineer plan
Issue orders	Issue orders

CONDUCT AN INTELLIGENCE PREPARATION OF THE BATTLEFIELD/ENGINEER BATTLEFIELD ASSESSMENT

Developing facts and assumptions is a detailed and sometimes lengthy process. The engineer must maintain his focus on the information required by the maneuver commander and his battle staff to make decisions. Facts and assumptions pertain to the enemy as well as the friendly situation. The engineer uses the EBA as the framework for developing facts and assumptions. The EBA consists of three parts (see Table A-2). They are—

- The terrain analysis.
- Enemy mission and mobility/survivability (M/S) capabilities.
- Friendly mission and M/S capabilities.

Table A-2. EBA

Component	Description
Terrain analysis	Analyze the terrain's impact on the battle using the OCOKA framework: • Observation and fields of fire. • Cover and concealment. • Obstacles. • Key terrain. • Avenues of approach. Analyze the advantages/disadvantages that the terrain offers the enemy and friendly forces. Analyze the conclusions on the terrain's impact on accomplishing the mission.
Enemy mission and M/S capabilities	Anticipate enemy engineer operations and their impact on the battle. Consider the enemy's mission and doctrinal employment of engineers in battle. Estimate the enemy engineer capability based on— • The S2's order of battle. • Threat engineer organizations. • Manpower/equipment capabilities. • Recent activities. Plot the enemy engineer effort based on— • The S2's situational template. • Doctrinal engineer employment.
Friendly mission and M/S capabilities	Evaluate the friendly engineer capability and its impact on accomplishing the mission. Consider the friendly mission. Estimate the engineer assets available based on task organization of— • Maneuver forces. • Engineer forces. • Higher engineer HQ. • Adjacent engineer units. Consider the availability of critical resources. Estimate the total engineer capability based on engineer planning factors.

To analyze the terrain and the enemy, the engineer commander uses the IPB and the EBA. The engineer XO uses the same process to assist in developing the TF's SITEMP and the engineer estimate. The IPB is a tool used to see the terrain and the enemy. The first two steps of the EBA do the same, but with an engineer focus. For example, the EBA will detail how the enemy engineers will modify terrain and develop EAs. This is critical information needed to complete the TF's SITEMP. However, the IPB process is used by the engineer to develop his "engineer-specific" IPB. The IPB is only two-thirds of the EBA process. The friendly engineer capability must be analyzed to complete the EBA. The TF engineer must use all assets and resources available—the TF S2, the brigade engineer, and the engineer battalion staff—during the IPB/EBA process.

The EBA is a continuous process that is continually refined as the situation becomes clearer. Each time new information is collected or the conditions change, the engineer must evaluate its impact on the mission and refine the facts and assumptions as necessary.

To do a proper EBA, the engineer company planner must understand the IPB process. The following paragraphs detail the IPB process and the engineer contribution to the completed product. For more information on the IPB, see FM 34-130.

INTELLIGENCE PREPARATION OF THE BATTLEFIELD

The IPB has four steps: define the battlefield environment, describe the battlefield's effects, evaluate the threat, and determine threat COAs.

Define The Battlefield Environment

Step one is the analysis of the AO, the battle space, and the area of interest. The TF engineer and company XO analyze the entire TF area, but focus in more detail on the AO. Additionally, the engineer company commander looks at the area directly affecting the engineer company. This step allows the engineers to focus their analysis efforts to a particular area.

Describe The Battlefield's Effects

Step two evaluates the effects of the environment with which both sides must contend. This environmental assessment always includes an examination of terrain and weather. It also includes an engineer-specific study of the area's infrastructure, facilities, equipment, and the framework needed for functioning systems, cities, or regions.

Specifically, weather analysis determines the effect of the weather on the mission. Weather affects terrain, equipment, visibility, and soldiers. Snow, dust, humidity, and temperature extremes all have an impact on soldier efficiency and limit the potential of weapons and equipment. Poor visibility affects obstacle placement. Normally, inclement weather will favor an attacker but will degrade his mobility and C^2. Defenders are less likely to be alert and weapons less effective. The attacker can close with the defender with greater ease in limited visibility conditions. Table A-3, page A-4, summarizes the effects of weather.

Terrain analysis is a major component of the IPB. The objective of the terrain analysis is to determine the impact that the terrain (including weather) will have on mission accomplishment. The engineer supports the intelligence officer in this process. Using the OCOKA framework (see Table A-4, page A-4), the engineer determines what advantages or disadvantages the terrain and anticipated weather offer to both enemy and friendly forces. This process has a direct impact on planning engineer operations. Table A-4 shows examples of how the components of OCOKA may impact engineer support.

Observation and Fields of Fire. Terrain and vegetation affect the friendly and enemy

Table A-3. Weather effects

Weather Condition	Element Affected
Temperature	Soldiers, gunnery, and equipment
Humidity	Soldiers and equipment
Precipitation	Soldiers, trafficability, and equipment
Visibility	Observation and obstacle placement
Light data	Observation and obstacle construction rate

Table A-4. OCOKA and sample M/S effects on planning

OCOKA		Examples of Effects on Engineer Support
Observation and fields of fire	Offense	Planning the obscuration/location of the support force for breaching operations.
	Defense	Obstacle distance from direct-fire systems (might also affect obstacle composition with reduced standoff). Limited fields of fire might limit certain obstacle effects (for example, fix and block).
Cover and concealment	Offense	Planning obscuration/assault positions for breaching operations. Impacts feasibility of conducting a covert breach.
	Defense	Required effort for survivability and deception operations.
Obstacles	Offense	Task-organizing special engineer mobility assets (such as AVLBs and ACEs). Plotting enemy countermobility effort, tying into existing obstacles.
	Defense	Tying in a reinforcing obstacle to existing obstacles might require an increased countermobility effort.
Key terrain	Offense	Targeting indirect-fire suppression and obscuration for breaching operations.
	Defense	Obstacle intents tied to how valuable the key terrain is for retention.
Avenues of approach	Offense	Capability to conduct in-stride, deliberate, and covert breaching operations. Focusing countermobility effort in a transition to a hasty defense. The need for flank protection.
	Defense	Focusing specific obstacle effects in a specific location in an AA. Size of AA impacts on required countermobility effort.

forces' capabilities to observe one another and engage each other with direct-fire weapons. Dead space is normally covered by indirect fire or sensors. Observation and fields of fire are used to identify potential EAs, defensible terrain, and specific system positions and to identify where maneuvering forces are most vulnerable to observation and fires.

In the defense, a potential mission for the engineer company is to improve fields of fire by cutting down trees, power lines, and vegetation. Intervisibility and unobstructed view from one point to another are other factors of observation and fields of fire. The analysis of both are critical to obstacle siting.

Cover and Concealment. Cover is protection from enemy fire. Concealment is protection from enemy observation. Both describe the viability of key terrain and the AA. Advances in technology, such as thermal sights, have affected the availability of concealment. The evaluation of concealment and cover aids in identifying defensible terrain, possible approach routes for breaching, assembly areas, and deployment and dispersal areas.

Obstacles. Obstacles are classified as both existing and reinforcing. Existing obstacles are further broken down into natural and cultural classes. Reinforcing obstacles include tactical and protective obstacles emplaced by soldiers to multiply combat power through terrain reinforcement.

The obstacles analyzed during the IPB/EBA process include both existing and reinforcing, but focus on existing obstacles. However, any reinforcing obstacles in the battlefield environment are included in the analysis. Obstacles define the AAs. They create cross compartments in the AA and can turn, fix, block, or disrupt maneuver. The following are examples of natural obstacles:

- Swamps.
- Dense forests.
- Deep, steep-sloped ravines.
- Rivers and streams.
- Hills or mountains with excessive slopes.

The following are examples of cultural obstacles:

- Urban areas.
- Quarries.
- Railroad beds.
- Built-up or elevated roads.

Reinforcing obstacles are those constructed, emplaced, or detonated to enhance existing obstacles or the terrain. Some examples of reinforcing obstacles are—

- Minefields.
- Tank ditches.
- Abatis.
- Tank walls.
- Road craters.
- Wire entanglements.

Built-up areas, rivers, steep elevation, and old friendly or enemy obstacle systems are normally analyzed for their effect on the AAs. A technique used to display the cumulative effects of obstacles is a graphical product that depicts areas of terrain as unrestricted, restricted, and severely restricted in terms of their effects on mobility.

Unrestricted terrain is fairly open and presents no hindrance to ground movement. Nothing needs to be done to enhance the force's mobility. Unrestricted terrain is a function of the type of unit moving on the terrain. Table A-5, page A-6, depicts the terrain that is considered to be unrestricted (favorable).

Restricted terrain hinders ground movement. Little effort is needed to enhance mobility. Restricted terrain is also a function of the type of unit traversing the terrain. Table A-6, page A-6, depicts terrain that is considered to be restricted and Table A-7, page A-7, depicts terrain that is considered to be severely restricted (unfavorable).

Key Terrain. Key terrain is any locality or area that affords a marked advantage to whichever combatant seizes, retains, or controls it. It is not necessarily the highest hill in the area. It could be a piece of high ground where a force can overlook low ground, a major road junction, or even a river or stream crossing site. Key terrain can be controlled by fire, obstacles, or the relative positioning of friendly forces. It is often selected for

Table A-5. Unrestricted terrain

Terrain	Unrestricted Criteria
Built-up areas	None
Hydrology	Rivers and streams are fordable along their length
Slope	30% or less
Vegetation	Trees less than 2" thick with 20 ft or more between them
Elevation	Variations from 0 to 100 meters per kilometer
Obstacles	None
Roads and trails	2 or more hard-surfaced roads per kilometer*
* Slope has priority over roads. Roads negate vegetation unless obstacles are used.	

Table A-6. Restricted terrain

Terrain	Restricted Criteria
Built-up areas	None
Hydrology	Rivers, streams, lakes, and flooded areas that can be forded at several places
Slope	30% to 45% uphill
Vegetation	Trees 2" thick with less than 20-ft intervals (mounted forces only)
Elevation	Variations from 100 to 200 meters per kilometer
Obstacles	None
Roads and trails	1 hard-surfaced road or 2 trails per kilometer*
* Except in open areas. Mounted forces only. Roads negate vegetation unless obstacles are used.	

battle positions or objectives, Some examples of key terrain are—

- Terrain which gives good observation over AAs.
- Terrain which permits the defenders to cover obstacles by fire.
- Important road junctions which affect the use of reserves, sustainment, or LOC.

AAs. Understanding AAs is the basis of military terrain analysis. The engineer should identify enemy battalion and regimental avenues and friendly company- and platoon-sized AAs. These approaches contain mobility corridors and cross compartments. AA analysis also offers potential EAs. The intersection of two or more AAs delineates a potential EA.

Table A-7. Severely restricted terrain

Terrain	Severely Restricted Criteria
Built-up areas	Wider than 500 meters or cannot be easily bypassed by mounted forces
Hydrology	Rivers, streams, lakes, swamps, and bogs that cannot be forded or spanned by an AVLB and that are not frozen. Hard, vertical banks higher than 4 feet will stop tanks as will streams more that 4 feet deep.
Slope	Slopes of 45% or greater uphill.
Vegetation	Trees, 6 to 8" thick and with less that 20-foot intervals (mounted forces only).
Elevation	Terrain with elevation variation of 200 to 400 meters per kilometer.
Obstacles	Minefields, tank ditches, tree blow down, and barriers (may be directional).
Roads and trails	One trail per kilometer and no hard-surfaced roads except in open area (mechanized or armored forces only).

Mobility corridors are areas within AAs that permit movement and maneuver. These are mostly open areas with good routes for rapid movement and mutual support. When existing or tactical obstacles cross an AA, they form lines of resistance called cross compartments. Table A-8 depicts the frontages that determine the size of the unit that can deploy along each mobility corridor.

Table A-8. Frontage

Unit Size	Frontage
Regiment/brigade	2,000 to 3,000 meters
Battalion	1,000 to 1,500 meters
Company	500 to 1,000 meters
Platoon	100 to 200 meters

Evaluate the Threat

Threat evaluation is the doctrinal capability of the enemy. The engineer analyzes the enemy's capability to fight as well as his engineer- specific capability. The enemy's capability to build obstacles and fortifications and how he doctrinally employs these capabilities are detailed and included in the intelligence estimate. Enemy weapons capability and how the enemy integrates obstacles into his defenses, fortifies defensive positions, and breaches obstacles are examples of engineer threat evaluation. The goal of threat evaluation is the development of a doctrinal enemy engineer template that shows how the engineer forces will be used and their capability in an unconstrained manner. Figure A-1, page A-8, shows an example of an MRC doctrinal template with obstacles. Figure A-2, page A-8, shows a typical MRB march formation.

Engineer threat evaluation should provide the TF S2 with the number of obstacles that the enemy can build (by type), the amount of fortification he is capable of, and how many breaches the enemy can complete given his equipment and doctrine. The engineer must

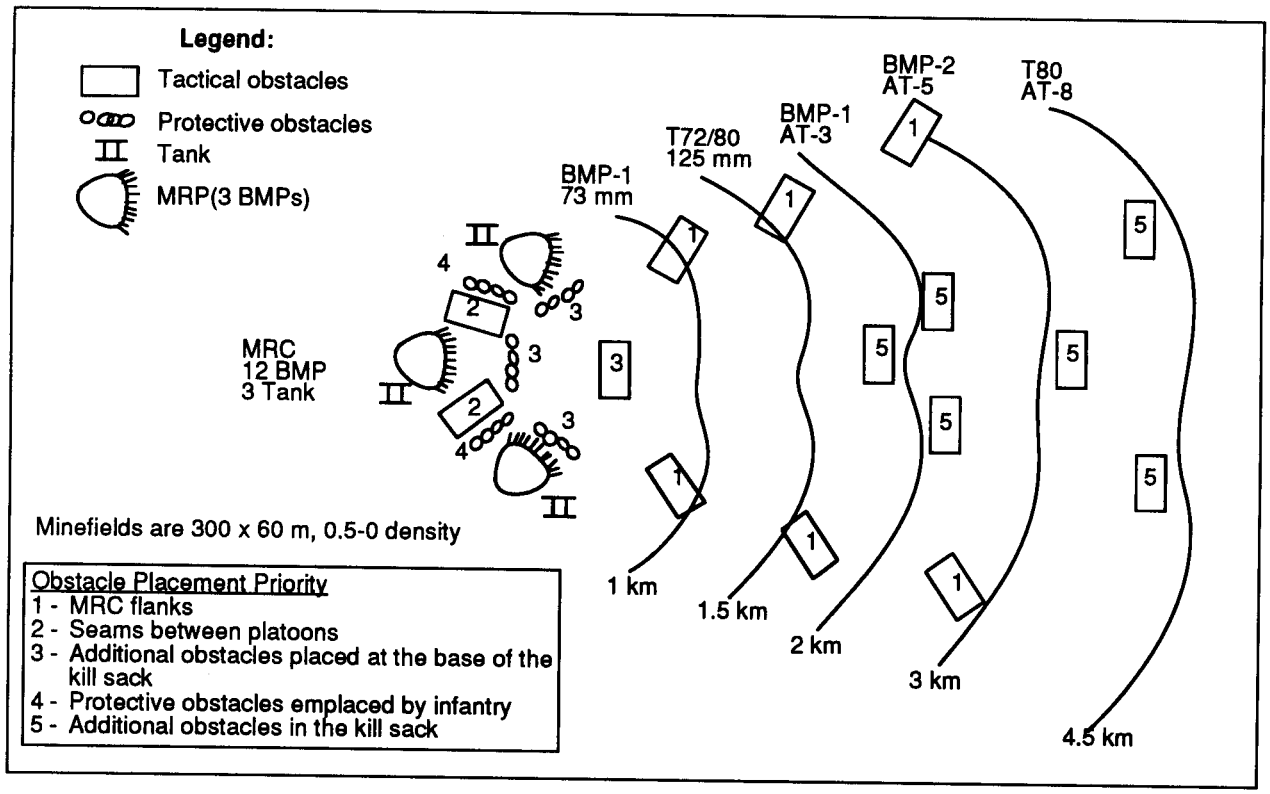

Figure A-1. MRC doctrinal template with obstacles

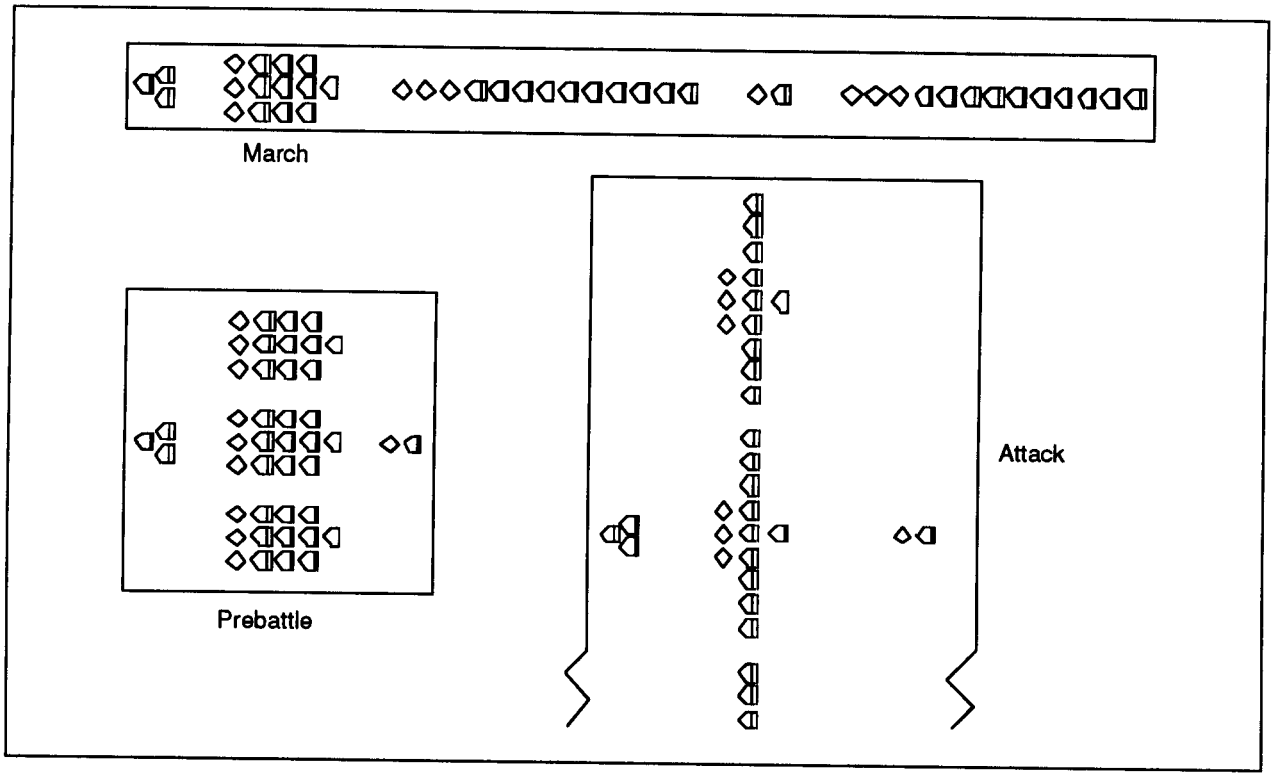

Figure A-2. Typical MRB march formation

ensure that these analyses are incorporated into the TF's SITEMP.

Determine Threat Courses of Action

The engineer, along with the TF S2, combines the doctrinal enemy template, the terrain analysis, and the other battlefield effects to gain an appreciation of how the enemy will use the terrain to fight. During this process, the enemy engineer capability (obstacles and fortifications) is graphically portrayed on the SITEMP. The engineer analyzes where the enemy has fortified positions, obstacles, potential counterattack routes, and so forth. The ultimate outcome of the threat integration is the SITEMP.

Threat analysis and integration are also major components of the IPB. Enemy mission and engineer capability are subcomponents of the threat-analysis and -integration process. The engineer supports the intelligence officer during the threat evaluation by focusing on the enemy's mission as it relates to enemy engineer capability. When executing this component of the EBA, the engineer must first understand the enemy's anticipated mission (attack or defend) and consider how enemy engineers will be doctrinally employed. He then develops an estimate of the enemy engineer capabilities. To do this, he uses the S2's order of battle and knowledge of enemy engineer organizations and other assets (such as combat vehicle self-entrenching capabilities) that may impact engineer operations. The engineer must also consider confirmed intelligence pertaining to recent enemy engineer activities.

The engineer then uses the S2's SITEMP and the enemy-capability estimate to plot the enemy's engineer effort and its location. Coordinating with the S2, the engineer recommends PIR and the engineer force necessary to augment the reconnaissance effort. Enemy engineer activities must be organic to the total combined-arms R&S plan. Table A-2, page A-2, contains a quick summary on enemy mission and engineer-capability analysis.

In the defense, the engineer plots the—

- Enemy's mobility capabilities and location in the enemy's formation.
- Enemy's use of SCATMINEs.
- Enemy engineers that support the reconnaissance effort.
- HVT recommendations (such as bridging assets, breaching assets, and SCATMINE delivery systems).
- Enemy's countermobility and survivability capabilities in a transition to a defense.

In the offense, the engineer plots the enemy's—

- Tactical and protective obstacle effort,
- Use of SCATMINEs.
- Survivability and fortification efforts.

ENGINEER BATTLEFIELD ASSESSMENT

At this point, the engineer has completed his IPB. He can now finish the EBA by analyzing the capability of the engineer company to support the TF.

The third component of the EBA estimates the friendly engineer capability and its impact on mission accomplishment. To perform this function, the engineer uses the information he developed in the first step of the engineer estimate (receive the mission).

Knowing the type of operation, the engineer quickly prioritizes the development of capability estimates. He considers engineer forces task-organized to his supported unit as well as the assets that other members of the combined-arms team have (such as mine plows) to determine the assets that are available. Assets under the control of the higher engineer headquarters and adjacent engineer units should be noted for future reference in the event a lack of assets is identified during SOEO development.

Having determined the assets available and having already estimated and refined the time available with the S3, the engineer uses standard planning factors or known unit work rates to determine the total engineer capability. For example, in the offense, the engineer would focus first on the amount of breaching equipment (AVLBs, MICLICs, ACES, engineer platoons, and CEVs) available and translate that into breaching lanes. In the defense, the engineer would determine the number of minefield, hull- or turret-defilade positions, and tank ditches that he could construct with available resources. He uses the results of his capability estimates during the SOEO development. Table A-2, page A-2, contains an outline of this analysis.

The engineer combines his analyses of the terrain, enemy capability, and friendly capability to form facts and assumptions about the following:

- Likely enemy engineer effort and the most probable enemy COA.
- Potential enemy vulnerabilities.
- Critical friendly requirements.
- The impact of the above factors on the mission.

The engineers determine their capability to support the TF. The TF engineer and XO analyze the engineer company's capability to emplace obstacles, prepare vehicle fighting positions, breach obstacles, and recommend where the terrain best supports the above.

The availability of key breaching equipment such as the ACE, the CEV, the AVLB, and the M1A1 plows and rollers, are tracked to keep the TF commander apprised of the breaching capability available. During the war-gaming phase of the tactical decision-making process, the engineer normally recommends the placement of TF breaching assets as well as the breaching technique based on the terrain and enemy obstacle threat. He also determines the number of lanes the TF potentially can make. Table A-9 shows the TF's breaching capability.

Likewise, the engineers provide the TF commander with details of the friendly capability to build fortifications and obstacles. Generally, this is done by meters of minefield or the number of obstacles and the number of fighting positions potentially available. These estimates are functions of time, equipment, troops, soil conditions, the unit training level and materials available. Table A-10 shows the engineer company's capabilities to create obstacles as well as planning factors for obstacle construction. Table A-11 shows the planning factors for fortification (for comparison, all equipment is available). This table uses the following planning factors:

Table A-9. Breaching capability

	Capability
Vehicle lanes (1 per engineer platoon)	2
Lanes with tank plows (this assumes 3 per tank company)	3
Lanes with line charges	4
17-meter gaps	4
NOTE: The number of tank plows is determined by the number of tank companies per TF.	

- 15 hours per day available to actually dig (remaining hours used for movement, maintenance, resupply, reconnaissance, position siting, and coordination).
- ACEs work in teams using 3.5 hours per two-tier vehicle fighting position.
- Dozers work in teams using 2.5 hours per two-tier vehicle fighting position.
- SEEs working individually using 1 hour per crew-served weapons position.
- All crews are assumed to be trained.

Table A-10. Engineer company capabilities

	Capability
Hand-emplaced obstacles	200 meters/hour
AT ditch	50 meters/hour
Volcano minefield	555 meters/15 minutes
GEMSS minefield	500 meters/15 minutes
FASCAM (artillery-delivered)	1 or 2 to plan
NOTE: Hand-emplaced rate is 100 meters per hour per platoon. AT ditch rate with two ACEs, Volcano, and GEMSS is for one load, blocking obstacles.	

Table A-11. Planning factors for fortification

Equipment	24 hr	36 hr	48 hr	60 hr
Dozer (X2)	12	18	24	32
ACE (X7)	12	19	25	32
SEE (X2)	20	40	60	60

ANALYZE THE MISSION

The engineer participates in mission analysis by identifying engineer tasks that are mission critical and have an impact on the overall mission. He identifies engineer tasks from the higher unit's entire OPORD, not just the engineer annex. He must look in numerous places to fully understand the total scheme of maneuver, the commander's intent, and instructions from the higher unit's engineer. The engineer should concentrate on the following portions of the OPORD as he receives and identifies the engineer mission:

- Mission (paragraph 2).
- Commander's intent (two levels up) (paragraphs 1b and 3).
- Scheme of maneuver (paragraph 3).
- SOEO (paragraph 3).
- Subunit instructions (paragraph 3).
- Coordinating instructions (paragraph 3).
- Service support (paragraph 4).
- Command and signal (paragraph 5).
- Engineer annex.

Mission analysis has several components. The engineer focuses on engineer capabilities within each component. These capabilities are—

- Specified tasks.
- Implied tasks.

- Assets available.
- Limitations (constraints and restrictions).
- Risk.
- Time analysis.
- Essential tasks.
- Restated mission.

SPECIFIED TASKS

Specified tasks are those derived directly from the WO, OPORD, or commander's intent. Examples include obstacle zones, obstacle belts with intents, the required number of breaching lanes, and the type of breach designated by the higher commander.

IMPLIED TASKS

Implied tasks are developed by analyzing the mission in conjunction with the facts and assumptions developed earlier. For example, obstacle-handover coordination during a relief-in-place mission, if not specified, is an implied task. A classic example of an implied task is identifying and planning a river-crossing operation to support an attack to seize an objective if a river crossing is necessary to accomplish the mission but is not specified in the higher OPORD.

ASSETS AVAILABLE

The engineer should have already identified the available engineer assets in the EBA. He should also examine the total force structure of the combined-arms team. This will help him as he develops the SOEO. For instance, the amount of firepower available may help to determine whether the force should conduct an in-stride versus a deliberate breach.

LIMITATIONS

Constraints are those specified tasks that limit freedom of action. Designated reserve targets, obstacle belts (with intents), and breach-lane requirements are examples of constraints the engineer must consider in his mission analysis. Restrictions are limitations placed on the commander that prohibit the command from doing something. Therefore, they impact greatly on the COA development. Obstacle zones and belts are excellent examples of restrictions because they limit the area in which tactical obstacles can be placed.

RISK

A commander might specify a risk he is willing to accept to accomplish the mission. For instance, the priority obstacle effort in a defense may be employed on the most likely enemy AA while situational obstacles are to be planned on the most dangerous AA as an economy-of-force measure. The engineer must understand how a risk involving an engineer capability will specifically impact on combined-arms operations and advise the commander accordingly.

TIME ANALYSIS

The engineer must ensure that engineer operations are included in the combined arms time analysis. First, he determines the actual total time available. While preparing the friendly capabilities portion of the EBA, he established a fact or assumption of the time available. He now refines this time analysis. A good tool to use in this process is a basic time-line sketch that includes such items as the—

- Supported unit's OPORD.
- Engineer unit OPORD.
- Movement times.
- LD or prepare-to-defend times.
- Rehearsals.
- Hours of darkness or limited visibility.

This technique assists the engineer in accurately refining the estimate of the amount of time actually available and adjusting the friendly engineer capability accordingly.

ESSENTIAL TASKS

Specified and implied tasks that are critical to mission success are identified as essential tasks. The engineer focuses the development of his plans, staff coordination, and resource allocation on the essential tasks. The engineer does not ignore the other specified and implied tasks, but his planning centers on the essential tasks.

RESTATED MISSION

The restated mission follows the same format as any mission statement. The who, what, where, and why are based on the mission analysis. The restated mission must clearly articulate the engineer's task and purpose during the operation.

DEVELOP THE SCHEME OF ENGINEER OPERATIONS

The engineer needs to receive planning guidance to tailor his SOEO. The amount of guidance required is based on the experience of the engineer and the maneuver commander, the time available, whether habitual relationships between the engineer and maneuver units have been established, and SOPs. Some areas in which the engineer might require guidance are—

- Situational obstacle planning.
- The use of digging assets (survivability versus countermobility).
- The use of maneuver forces in the obstacle effort.
- Risk acceptance of M/S tasks.
- Interpretations of the higher commander's intent pertaining to M/S.

COA development centers on employing maneuver forces. However, the engineer assists in the process by considering the impact engineer operations have on maneuver. The engineer must participate in order to tailor the SOEO for each COA. He develops an SOEO for each maneuver COA. He does not develop complete plans, just his concept. It is developed using the same steps as the maneuver COA but without the detailed force allocation. If time permits, the engineer may begin working on the details for each plan (see Table A-12).

ANALYZE RELATIVE COMBAT POWER

The engineer compares the anticipated enemy engineer capability with the friendly engineer capability needed to defeat it. For example, in the offense, the engineer considers the enemy doctrinal norms, confirmed intelligence, recent activities, and the time

Table A-12. SOEO development

Development Process
Analyze relative combat power.
Identify engineer missions and allocate forces/assets.
Develop an SOEO.
Balance assets available with support requirements.
Integrate into the maneuver COA.

the enemy has to prepare and then determines if the friendly engineer capability is sufficient to overcome the enemy capability. Likewise, in the defense, he looks at enemy breaching capability and where and when he expects that capability to be employed. Then he determines what obstacle effect will defeat it and what assets are available to ensure success.

IDENTIFY ENGINEER MISSIONS AND ALLOCATE FORCES

Based on the maneuver COA, situation analysis, mission analysis, and commander's intent, the engineer assesses the engineer requirements. This is the most important step in developing an SOEO.

DEVELOP A SCHEME OF ENGINEER OPERATIONS

The SOEO focuses on how the engineer effort integrates into and supports the maneuver COA. Like the maneuver COA, the SOEO is generic without a specific engineer force allocation or unit designation. It must address all phases of the operation, particularly where engineer priorities must change to support the maneuver.

BALANCE ASSETS AGAINST SUPPORT REQUIREMENTS

The engineer reviews his SOEO in light of the assets he has available (using his EBA product). Hasty estimate tools (such as belt planning factors, blade-hour estimates, and breach-lane requirements) are used to quickly assess whether adequate assets are available to support the plan. All shortfalls are noted and the SOEO is refined, if necessary. The SOEO is refined by—

- Shifting assets to the main effort.
- Shifting priorities with the phases of the operation.
- Recommending to the commander where to accept risk.
- Requesting additional assets.

INTEGRATE INTO THE MANEUVER COURSE OF ACTION

The engineer prepares a statement describing the SOEO. This statement addresses how engineer efforts support the maneuver COA. He integrates the necessary graphics to illustrate this tentative engineer plan (for example, breaching control measures and obstacle graphics and intents).

WAR-GAME AND REFINE THE ENGINEER PLAN

Staff analysis identifies the best COA for recommendations to the commander. War-gaming techniques are used to analyze the COAs. War gaming is a systematic visualization of enemy actions and reactions to each friendly COA. The engineer participates in war gaming to ensure that the SOEO supports the maneuver plan and is integrated with the other staff elements; to further identify weaknesses in his plan and make adjustments, if necessary; and to ensure that the S2 integrates enemy engineer assets and actions as he plays the enemy force. There are three techniques for war gaming: avenue in depth, belt, and box (see Table A-13).

After each COA is independently war-gamed, the results are compared. The goal of comparing COAs is to analyze the advantages and disadvantages of a COA relative to the other plans. Each COA is compared to the others using specific evaluation criteria. These evaluation criteria may be developed by the staff or may be directed to the staff by the commander during his planning guidance.

The engineer compares COAs in terms of which SOEO best supports mission accomplishment. His comparison is only part of the total comparison by the staff.

Table A-13. War-gaming techniques

Technique	Description
Avenue in depth	This technique concentrates on one AA from start to finish. It is equally applicable to offensive and defensive operations. It allows the engineer to war-game the analyzed impact of enemy obstacles on the attack plan and the effects of sequential obstacle belts or groups for the defensive plan.
Belt	The belt technique divides the battlefield into areas that run the width of the sector, war-gaming across the front and multiple avenues at once. This is the preferred technique. It allows the engineer to war-game the mutual support between obstacle belts and groups. It is the best method for analyzing mutual support and adjacent engineer support.
Box	This technique focuses solely on critical enemy or friendly events in a designated area (box). The advantage of this method is that it is not time-consuming. It allows the engineer to focus on a particular breaching site or EA.

RECOMMEND A COURSE OF ACTION

The objective of the comparison is to make a unified recommendation to the commander on which COA is best. The engineer may have to give greater consideration to a COA that he can least support if it looks like it is the best selection from the other staff perspectives. He must be prepared to inform the maneuver commander where risk must be accepted or what additional assets he will need to avoid that risk. The engineer must also be prepared to inform the maneuver commander where those assets may be obtained and what influence the commander may have to exert to get them. This is where knowledge of the higher and adjacent unit's engineer assets becomes important.

Based on the staffs recommendations, the commander makes a decision on which COA to adopt for final planning. He may select a specific COA, modify a COA, or combine parts of several COAs. In any event, the commander decides and issues to the staff additional guidance for developing the plan. This guidance concentrates on synchronizing the fight, focusing on integrating the TF combat support into the plan.

FINALIZE THE ENGINEER PLAN AND ISSUE ORDERS

The engineer focuses his planning efforts on the SOEO for the selected maneuver COA, The engineer determines the C^2 necessary to accomplish the engineer missions (see Chapter 2 for additional information). The SOEO is fine-tuned based on the war-gaming process, commander's guidance, and situation updates. As the engineer fills in the details of his plan, he refers back to his initial mission analysis to ensure that all missions have been taken into account. He ensures that all engineer tasks are assigned to maneuver and engineer units as part of the subunit instructions. He makes final coordination with other staff members to ensure total integration and mutual support.

The engineer conveys his written plan through his input in the basic OPORD (SOEO, subunit instructions, and coordinating instructions paragraphs) and the engineer annex (see Appendix B). As part of the combined-arms staff, the engineer also participates in the OPORD brief to the assembled command group. As with the other primary staff officers, the engineer gets only one chance to brief the command group on

the SOEO. This is the first step in a properly executed and well-coordinated engineer plan.

The engineer's focus is to brief the subordinate commanders; the maneuver commander and staff should already know the plan. Time is always critical; repeating information covered by other staff members should be avoided, and only critical items should be covered (including SOP items). Above all, the engineer should be thoroughly familiar with the total plan so that he is comfortable fielding questions.