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This paper looks at the personnel casualty estimation methodology used by CAA. The models employed in the estimation process are discussed and the sources of data/rates used by the models are identified. Finally, some of the strengths and limitations of the methodology are listed.

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TECHNICAL PAPER

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CAA CASUALTY ESTIMATION METHODOLOGY

February 1984

Prepared by

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FOREWORD

This paper describes the methodology used at CAA for estimating personnel casualties. The discussion keys on the type inputs and models that are used in the process, with emphasis on how the models play personnel attrition and the key role played by the input factors. Finally, there is a listing of strengths and limitations associated with this methodology.

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CAA CASUALTY ESTIMATION METHODOLOGY

1. INTRODUCTION. The basis for CAA personnel casualty estimates is the systematic application of a series of loss rates applied over time to changing populations in the division, corps, and communications zone (COMMZ) of the theater. This is accomplished by interfacing a series of models developed primarily for conducting force structure studies. The models are: (1) the Transportation Model (TRANSMO), (2) the Combat Sample Generator Model (COSAGE), (3) the Concepts Evaluation Model (CEM), (4) the Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS) Model, (5) the Patient Flow Model (PFM), and (6) the Casualty Stratification Model (CSM). Figure 1 is a representation of the interface between these models and their relationship in generating casualty data. COSAGE produces killer/victim scoreboards, which are used to calibrate CEM for the calculation of casualties in the division area. Unit closures produced by the TRANSMO provide a time-phased unit buildup of the force. The FASTALS Model distributes support units to the combat area, corps area, and COMMZ based upon doctrine and upon workloads generated by the combat intensities from the CEM. FASTALS computes casualties suffered by noncombat units while determining support force requirements. Combat zone casualty data from the CEM and support unit losses from FASTALS are inputs to the PFM, which determines personnel returned to duty (RTD), died in theater hospitals (DIH), and those that are to be evacuated to CONUS. The CSM stratifies casualties by MOS and grade, over time. Greater detail concerning model characteristics and specific application to personnel attrition are addressed in the models section of this paper. Since most casualty data is rate or factor driven, the key parameters and their sources will be covered in the section covering the supporting models.

2. TYPES OF CASUALTIES. Personnel losses are identified in three general categories:

a. Battle, which are those losses incurred in action including:

(1) Wounded or injured in action (WIA).

(2) Killed in action (KIA).

(3) Captured by the enemy or missing in action (CMIA).

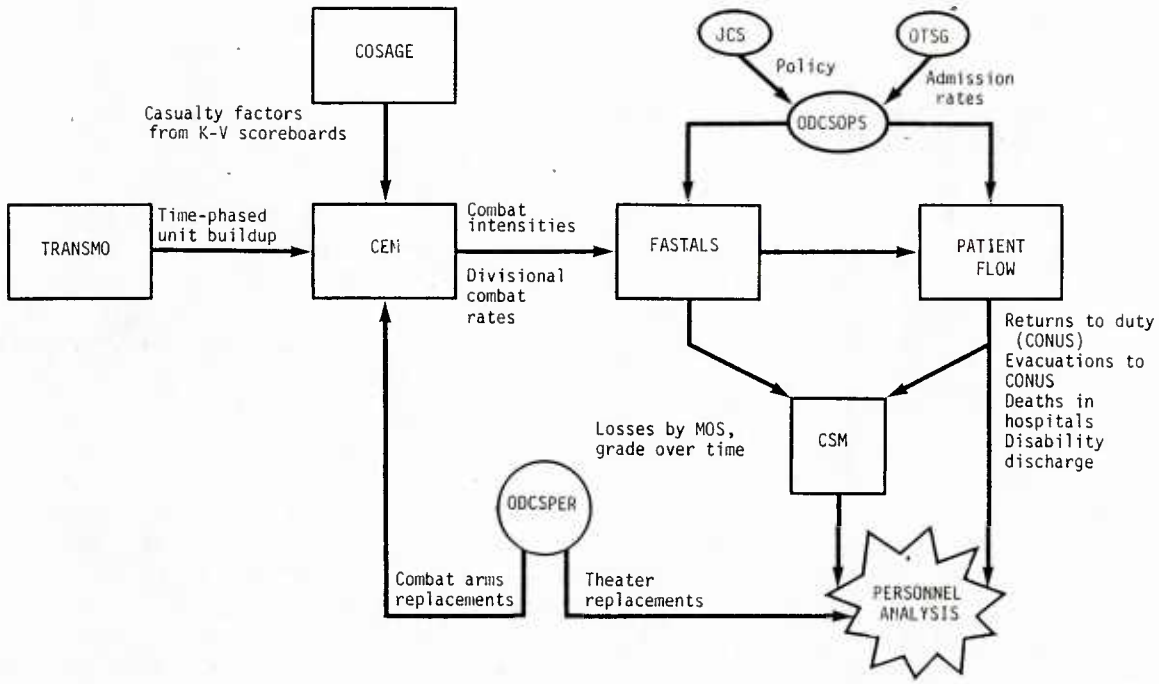

Figure 1. Data Flow for Casualty Estimation

b. Diseased and nonbattle injuries (DNBI) are those losses not directly attributable to being in action and include:

(1) Nonbattle dead.

(2) Nonbattle accident/injury.

(3) Sick/disease.

c. Administrative (not included in the CAA estimates) are those losses including:

(1) Absent without leave.

(2) Desertion.

(3) Rotation of personnel.

(4) Discharges.

3. COMPUTATION

a. The echelon and the casualty rate over time are contributing relationships to the casualty level. In simplest mathematical terms, a casualty estimate is the product of a casualty rate times population size times time period length:

$$C = P \times R \times T$$

where: C = the casualty level

P = the population

R = the loss rate

T = time period length

b. When different echelons and the dimension of time are added, the formula expands. For example, the CAA methodology employs three echelons (division, corps, and COMMZ) and 18 time increments (the end of each 10-day time period for a 180-day simulation). Thus, the expression becomes

$$C = \sum_{t=1}^{18} (P_{1,t}R_{1,t} + P_{2,t}R_{2,t} + P_{3,t}R_{3,t})\ T$$

where: subscript 1 applies to division, 2 to corps, and 3 to COMMZ.

c. This is the conceptual framework for the estimation process. It has the advantage of being able to represent various rates (R) with varying populations (P). This process reduces the anomalies normally encountered when a single casualty rate is used for the duration of a theater campaign.

d. The development of values to be applied to the above equation is by far the most difficult task. There are varying degrees of uncertainty to the data sources and inputs to the methodology. There is reasonable confidence in the validity of the population data against which the casualty rates are applied. Most of the uncertainty is in the casualty rates and is discussed below.

(1) CAA studies indicate that division area rates are higher and more sensitive to tactical postures and combat intensities than are corps and COMMZ rates. Wargames, which simulate varying results over time, can therefore be a basis for estimating combat casualties within the division area.

(2) Casualty rates applied to corps and COMMZ area forces are based on historical data provided by the Office of The Surgeon General (OTSG), the Office of the Deputy Chief of Staff for Operations and Plans (ODCSOPS), and FM 101-10-1.

(3) The calculations to support estimates of diseased and nonbattle injury (DNBI) rates by echelon are based on historical data provided by the OTSG.

4. DISCUSSION OF SUPPORTING MODELS

a. COSAGE

(1) General Description. COSAGE is a two-sided, symmetrical, high resolution, stochastic simulation of combat between two forces. It is a discrete event simulation with stochastic phenomena modeled through events and processes. Typically, the Blue force (side) is represented as a division and the Red force (side) is scaled from a fraction of a division to a combined arms army. The model simulates periods (normally 24 hours) of combat and produces expenditures of ammunition by round type and losses of personnel and equipment. Maneuver unit resolution is typically down to Blue platoons and Red companies. In the case of close combat, resolution is to the individual equipment and weapon level.

(2) Unit Arrays and Files. The Blue and Red forces are placed on a representative battlefield in accordance with current doctrine and intelligence projections. The positioning of these forces constitutes an array, and different arrays are developed to represent various combat activities, or postures. Those normally arrayed are: Blue prepared defense, Blue delay, static, Red prepared defense, and Red delay. Unit files are developed to describe each Blue and Red unit on the simulated battlefield. The unit file provides the initial coordinates of the unit, the weapons and equipment which will be normally assigned to the unit, and the personnel.

(3) Personnel. In the unit file, personnel assigned to the unit are described in the manner that they would be found during the combat operation being portrayed. For example, a mechanized infantry platoon in the offense would have all personnel on board their infantry fighting vehicles, while this same platoon in a static situation would have the infantrymen dismounted. The model does not have the capability to mount and dismount personnel during the different actions of a single combat operation.

(4) Personnel Attrition. Personnel can be hit by all weapon systems included in the combat simulation. All direct fire systems which would logically fire at a person during the course of a combat simulation have a single shot probability of kill (SSPK) which is variable, depending on range. Direct fire systems that would engage equipment-carrying personnel have similar probabilities of kill. Indirect fire systems, including TACAIR, have lethal areas for each type munition fired against personnel and equipment. Lethal areas against personnel are reduced for personnel in protected positions.

(5) Killer/Victim Scoreboard. The killer/victim (K/V) scoreboard lists are personnel and equipment which interact during the combat simulation. Personnel losses are classified as belonging to maneuver units, artillery batteries, or headquarters and supported units. Crewmen on board weapons systems, such as tanks and IFVs, are not listed. Their attrition is accounted for in the theater warfare model, CEM. The CEM assumes that the personnel losses in the K/V scoreboard include wounded, killed, captured, and missing in action.

b. Concepts Evaluation Model (CEM)

(1) CEM is the warfighting model used by CAA for evaluation of general purpose land forces. It is a fully automated, deterministic, theater level combat simulation that considers:

- Estimates: divisions, corps, army
- Decisions: division, corps, army, theater
- Logistics: consumption and resupply
- Personnel: losses and replacements
- Weapons: losses and replacements
- Terrain effects
- Artillery, TACAIR, and air defense
- Force mix: battalion and higher

(2) The commander's estimate of the situation is the basis for decisions. Status files are maintained for each Blue brigade and Red division for the logistics items of POL, ammunition, and other supplies for each major item of equipment and for personnel. Terrain effects are considered. Artillery and tactical air support and the effect of air defense on tactical air are also considered. The model is sensitive to force mix, particularly to the major weapons mix of the opposing forces.

(3) A simplified block diagram of the CEM cyclical operation is shown in Figure 2. Input is in the form of forces and scenario data, such as arrivals of reinforcing divisions, artillery battalions, terrain, and estimation and outcome force ratio thresholds. Logistics inputs consist of prestocks, arrivals by time period, and movement factors. The model cycles through estimates, decision, combat assessment (in terms of FEBA movement), attrition, and consumption which affect the unit status and the next cycle. Some specific details of the model follow.

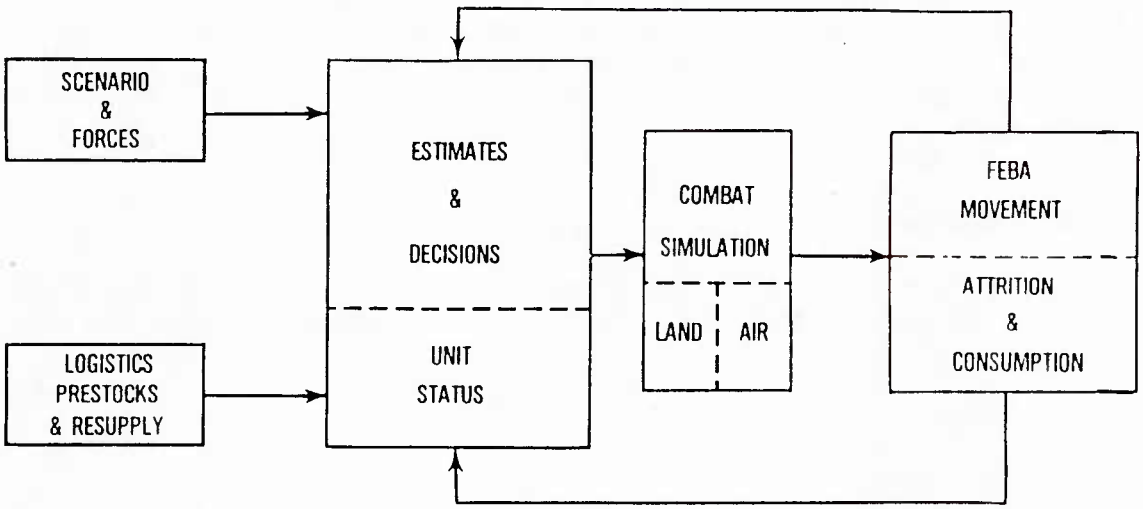

Figure 2. Concepts Evaluation Model (CEM)

(4) Forces are defined in CEM at battalion level in terms of their weapons and logistics items. Each of the higher echelons are defined in terms of the next lower echelon, e.g., brigades have battalions, divisions have brigades, etc. Major weapons are described by high resolution killer/victim scoreboards, supply consumption rates, crew size, vulnerability factors, and breakdown rates. Battalions are described by numbers of the major weapons and by supply consumption rates, personnel, and authorized levels of supplies. For the Blue side, three separate logistics systems can be represented for maintenance, personnel, ammunition, POL, and other supplies, allowing for distinction between the US and its allies.

(5) The independent decisions made by each side determine the type of engagement to be assessed. The mission for each side is determined by unit, Blue brigade or Red division, but the engagement type is determined at subsector level and may well be different for portions of the same unit. There are nine CEM engagement postures as follows:

(a) Blue Attack Delay (BAD)

(b) Blue Attack Prepared Defense (BAPD)

(c) Blue Attack Hasty Defense (BAHD)

(d) Meeting Engagement (ME)

(e) Red Attack Hasty Defense (RAHD)

(f) Red Attack Prepared Defense (RAPD)

(g) Red Attack Delay (RAD)

(h) Static

(i) Reserve

(6) CEM VI Casualty Assessment

(a) Losses of personnel and equipment in CEM are assessed for each Blue brigade for every 12-hour time period simulated. Losses are dependent on the mission of both sides in the brigade sector, on the type of terrain in the sector, and on the numbers of each type of weapon on both sides on hand in the brigade sector. Attrition parameters for each terrain-posture combination are input to the CEM VI in the form of a detailed killer/victim scoreboard, which includes the number of rounds fired at each type target and hits of each type target by each weapon played in the CEM VI. Within the CEM VI an attrition model, using the calibrated parameters (ATCAL) process, is used to extrapolate the number of rounds fired by each weapon in a particular brigade engagement from the number of rounds fired in the input killer/victim scoreboard. The rounds fired, along with the lethality per round of the killer/victim scoreboard, determine losses. The killer/victim scoreboards input to CEM VI are currently obtained from the division level combat simulation (COSAGE). The effective firepower (or combat worth) of each combat unit used in CEM estimation and decisions is based on the numbers of enemy weapons hit in that unit's sector, and the combat worth is updated after each 12-hour engagement.

(b) Figure 3 depicts personnel flow in CEM. Arriving personnel replacements go to a theater personnel pool. They are subject to a delay, depending on the air environment, before they are assigned to maneuver units. When available replacements are less than requirements, unit fill is proportional to its needs. Noncombat (DNBI) losses are generated by an Army Force Planning Data and Assumptions (AFPDA) factor (based on FM 101-10-1) which is applied to the on-hand maneuver unit strength. For the combat force, casualties are divided into WIA, KIA, and MIA, depending on engagement type (see Table 1). A portion of the WIA and sick are considered treated at aid stations and returned immediately to units. The remainder are hospitalized, either in theater or evacuated, as determined by the evacuation policy. Those that are evacuated, the KIA, MIA, and the noncombat dead, are all considered permanent losses to the theater. Those hospitalized in theater are delayed for a time (established by input, a function of the evacuation policy) and then returned to the theater distribution pool for issue to units.

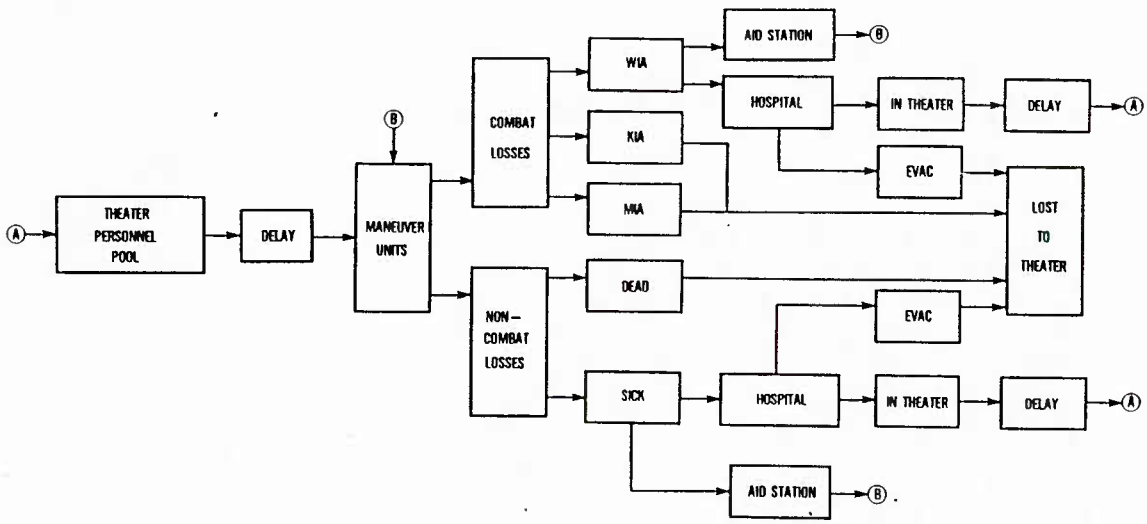

Figure 3. Personnel Accounting

1. **Distribution of Noncrew Casualties.** Noncrew casualties are categorized as killed (KIA), wounded (WIA), or captured/missing (C/MIA) according to the distribution shown in Table 1.

Table 1. Percentage Distribution of Blue Noncrew Personnel Casualties (source: FM 101-10-1)

Engagement type	KIA	WIA	C/MIA
RAPD	25	69	6
RAHD	16	70	14
RAD	15	45	40
ME	19	75	6
BAPD	16	81	3
BAHD	18	70	12
BAD	19	76	5

2. **Distribution of Crew Casualties.** Crew personnel suffer casualties only when their vehicle or weapon is damaged or destroyed. Therefore, the number of crew casualties depends on equipment damage calculations. Distribution factors, such as those shown in Table 2, are applied to determine crew personnel casualties from vehicle damages and the further breakout of those casualties between KIA and WIA. Note that CEM does not assess C/MIA casualties for crew personnel.

Table 2. Number of Crew Casualties by Type Vehicle Incapacitated (source: AMSAA)

Vehicle	Casualties	KIA	WIA
Tank	1.6	0.8	0.8
APC	0.8	0.4	0.4
Helicopter	0.8	0.4	0.4

3. Division Personnel Casualties. Figure 4 summarizes the division personnel casualty computation process. Note that CEM results are only for combat personnel and are modified in the FASTALS preprocessor by use of the factor 1.075 to derive the total division casualty estimate. This factor, based on historical evidence contained in FM 101-10-1, accounts for casualties within the division which are not represented by the "shooters" or combat arms population in CEM. DNBI rates for the division are calculated separately within the PFM.

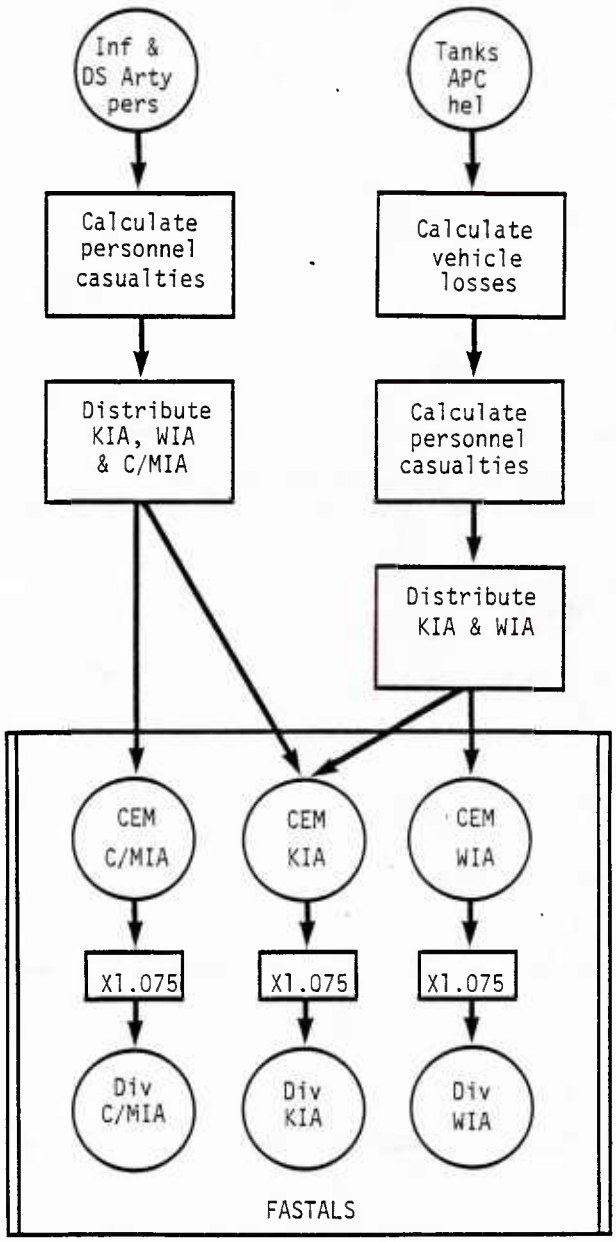

Figure 4. Calculation of Division KIA, C/MIA, and WIA

(7) CEM Inputs/Outputs (personnel)

(a) Inputs. The CEM warfighting simulation requires the following input parameters related to personnel casualties. Sources of each are indicated in parentheses.

- Personnel vulnerability factors (K/V boards) for troops in artillery battalions, in reserve units, and maneuver units in each of eight postures (COSAGE).
- The fraction of the personnel combat losses that are killed among troops in reserve units and in each of the eight postures (FM 101-10-1).
- The fraction of combat losses that are wounded in reserve units and in each of the eight postures (those remaining are captured and missing) (FM 101-10-1).
- The number of crew personnel of each combat vehicle that become casualties, given that the vehicle is hit (AMSAA).
- The number of crew personnel of each combat vehicle that are wounded, given that the vehicle is hit (the remainder of the crew casualties are killed) (AMSAA).
- The fraction of wounded in action requiring hospitalization (those remaining are treated at aid stations) (OTSG).
- The fraction of the hospitalized wounded in action sent to theater hospitals (those remaining are evacuated) (OTSG).
- Nonbattle losses per 100 men (OTSG).
- Fraction of nonbattle losses that are killed (FM 101-10-1).
- Fraction of surviving nonbattle losses requiring hospitalization (the remainder are treated at aid stations) (OTSG).
- The time personnel must remain in hospitals (minimum is 4 days) (OTSG).
- The time delay encountered by replacement (new arrivals in theater from ports and hospitals) personnel to reach front lines (AFPDA-ODCSPER).

(b) Outputs. CEM documents personnel casualty data in two of its output reports--the Logistics Report and the Blue Personnel Report.

1. The Logistics Report lists by theater cycle (4-day) time period:

- Authorized personnel
- On hand personnel
- Combat - temporary and permanent losses of personnel
- Noncombat - temporary and permanent losses of personnel

2. The Blue Personnel Report lists by day:

- Combat losses
  - KIA
  - WIA (not including aid station)
  - CMIA
- Noncombat losses
  - Dead
  - Sick
- Totals (combat and noncombat)
  - Dead
  - Entered into hospital
  - Evacuated from theater
  - Total hospitalized
  - To aid station only

c. Force Analysis Simulation of Theater Administrative and Logistic Support (FASTALS) Model

(1) Purpose. The FASTALS Model computes administrative and logistical workloads and generates the theater level support force structure requirements necessary to support a combat force in a contingency. Support to combat units is defined as the doctrinal logistical and administrative service support necessary to support a tactical unit activity. Elements of

support represented in FASTALS include maintenance, construction, supply, transportation, storage, troop hospitalization, and troop replacement. Requirements for units performing these functions are derived from workloads of the tactical and support units. Workloads are computed using factors developed by TRADOC (and approved by HQDA) as a function of the combat force deployment, theater environmental conditions, and the tactical results as described to the model by the warfighting model, CEM.

(2) Characteristics. FASTALS is a fully automated, deterministic computer model which is driven by the results of combat simulations, such as the CEM, as well as planning factors and rates which are developed separately for estimating workloads not discretely measured in the warfight simulation.

(3) Application. Casualty and replacement personnel estimates are computed in FASTALS using combat simulation results, admission rates, and medical and evacuation policies as prescribed by the Office of The Surgeon General. Figure 5 illustrates the interrelationship of input, processing, and output for the medical and personnel workloads in FASTALS. Divisional DNBI admission rates are used to compute nonbattle losses to combat forces, and the total WIA losses and K/CMIA losses for combat forces are provided directly from the CEM. FASTALS then computes nondivisional admissions by multiplying an applicable rate (either WIA or DNBI) by the population at risk. It combines these with the divisional admissions and, using the accumulation and disposition (AD) factor tables, generates the remaining in hospital (RIH) and return to duty (RTD) workloads. The accumulation and disposition tables are the prime components in determining the RIH and RTD values. Since the medical workload deals with two admission types (WIA and DNBI), two-patient status (RIH and RTD), and two levels of the hospitalization system (combat zone and COMMZ), eight AD factor tables are needed. These tables are a function of time period length and the evacuation policies in effect for each period and are obtained by use of the PFM. Evacuation policies are constrained by the available set of policies in the PFM data base (these include 5-, 10-, 15-, 20-, 30-, 45-, 60-, and 90-day policies). Theater personnel replacement requirements are determined by summing losses due to all causes, including WIA, DNBI, and K/CMIA, and reducing this gross requirement by the returns to duty from corps and COMMZ hospitals.

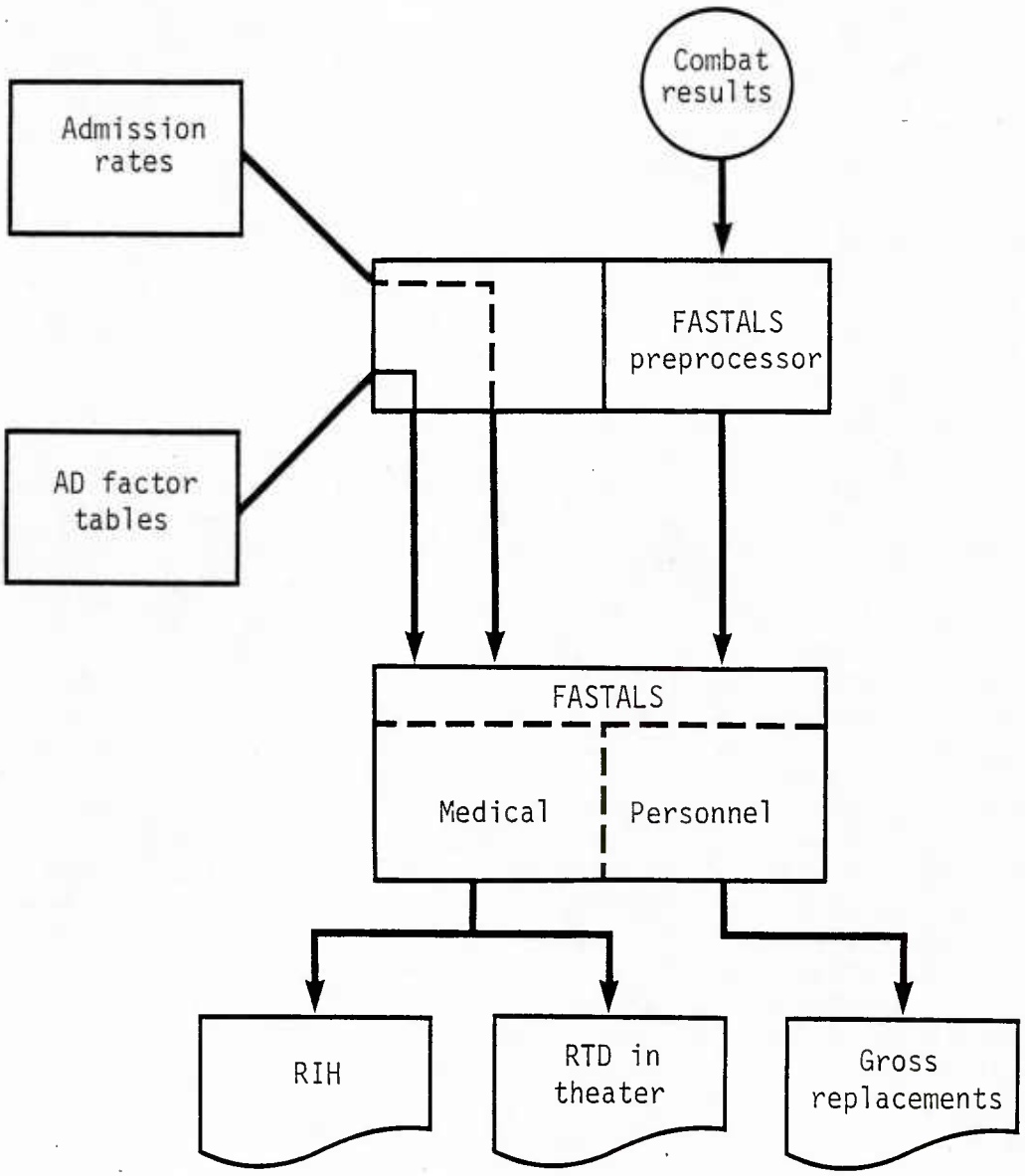

Figure 5. Medical and Personnel Computations

d. Patient Flow Model (PFM)

(1) PFM Features. The PFM is an expected value model used to simulate medical workloads required to support both combat and noncombat casualties. Division combat casualties (WIA) from the CEM are processed

through FASTALS to provide strengths and rates for input to the PFM to produce theater-wide casualty information. The model inputs and outputs are summarized below.

(a) Inputs

- Hospital admission rates
- Average troop strength by time period
- Evacuation policy

(b) Outputs

- Hospital admissions
- Deaths in hospital (DIH)
- Evacuation (EVAC)
- Returns to duty (RTD)

(2) PFM Inputs

(a) Hospital Admission Rates. Time-phased rates by echelon are input to the PFM for both WIA and DNBI hospital admissions. Division WIA rates are computed with FASTALS output data, while all other WIA rates and the DNBI rates for all echelons are provided by the OTSG through the ODCSOPS, based upon medical historical data. Division WIA rates are determined by the following method: if C = P x R x T, then R = C/(P x T); thus DIV WIA RATE = DIV WIA/(DIV POP x time period length). Table 3 shows an example of hospital admission rates which were input to the PFM for the Total Army Analysis FY 86-90 (TAA-90) Study. These rates are expressed as the rate per 1,000 strength per day.

Table 3. Theater WIA and DNBI Rates

Time period	Division rates		Corps rates		COMMZ rates	
	WIA[a]	DNBI	WIA	DNBI	WIA	DNBI
D to D+30	5.90	5.65	1.73	1.20	.84	1.20
D+31 to D+60	4.90	4.10	1.38	1.20	.69	1.20
D+61 to D+90	2.98	2.25	1.38	1.20	.69	1.20
D+91 to D+180	3.38	1.80	.68	1.20	.13	1.20

[a]WIA rates generated by combat simulations for TAA.

(b) Average Troop Strength. A time-phased population buildup is distributed to each echelon within the theater by the FASTALS Model.

(c) Evacuation Policy. The JCS theater policy currently used in the model for the limit of in-theater hospitalization prior to evacuation is shown in Table 4.

Table 4. Theater Medical Evacuation Policy and Limit of Expected Hospitalization

Time/ Category	Mobilization period	D to D+30	D+31 to D+60	D+61 to D+180
Expected combat zone hospitalization	7 days	7	7	7
Theater evacuation policy	15 days	15	30	60

(3) PFM Outputs. The PFM determines three possible outcomes at each echelon. These outcomes are: (1) DIH, (2) RTD, or (3) EVAC to a higher echelon. The model repeats this sequence through each echelon back to CONUS. The model accounts for the number of personnel within each echelon's hospital during each time period and the cumulative number of the other outcomes by echelon. Cumulative totals of (1) deaths within the theater hospitals, (2) evacuees to CONUS, and (3) noncumulative temporary personnel hospitalized contribute to the total theater casualties. Returns to duty from CONUS hospitals become inputs to the theater individual replacement pool.

(4) Corps and COMMZ Casualty Rates. Historical data (FM 101-10-1) shows that the distribution of corps casualties are, on the average, about 16 percent killed and 84 percent wounded. Using the corps WIA rates provided by The Surgeon General, the corps population provided by FASTALS, and the distribution of casualties between wounded and killed, estimates of KIA in the corps area and COMMZ are determined as a constant 19 percent of the WIA.

e. Casualty Stratification Model (CSM). The CSM is used to stratify total casualties by grade, category (combat, medical, etc.), and MOS. It is used to provide casualty data to a degree of specificity required by the Army. In its original and improved versions, the degree of specificity can be varied by the analyst to conform to the requirements of the particular study in which it will be used.

(1) General Characteristics

(a) The CSM, also known as the Personnel Postprocessor and/or Fort Ben Harrison Model, was developed at the US Army Soldier Support Center in 1977 as a part of the TRADOC Post Mobilization Training Requirements Study. It was designed to distribute theater or major force level total casualty figures into specific replacement needs by three-digit MOS and grade. The algorithm was to be used with major force level models to "postprocess" the aggregate casualty results of these models. A basic assumption was made that the warfight model took into account the details of the situation, mission posture, threat, or other significant variables when calculating the gross casualty figures.

(b) The general methodology employed in developing the CSM algorithm was to first determine a "vulnerability rate" for the various branches or functional areas, and then to assign a "loss factor" to each MOS found within a branch or functional area. The branch vulnerability rates were obtained through the analysis of output from the CEM. In determining the MOS loss factors, the MOS were grouped into branches or functional areas and then evaluated in relation to each other as to the job duties, population densities, and probable location of each MOS on the battlefield. The major assumption underlying this was that the percentage of casualties attributable to a given MOS is directly proportional to the vulnerability of that MOS. The final step in the methodology was to apportion the casualties by grade. The technique of this operation is based on the assumption that casualties within an MOS are distributed in direct relationship to the grade densities within that MOS.

(c) The basic steps in the CSM stratification process are relatively simple. The total casualty figure is first sorted into officer, warrant officer, and enlisted categories based upon the distribution of these categories within the force. Next, the vulnerability rates are applied to further sort the casualties per each of the three categories into branch/functional areas. The branch/functional area casualties are then distributed to the various MOS within that branch/functional area by use of the MOS loss factor. Finally, the casualties within each MOS are sorted by grade based upon the number of personnel in each grade within that MOS in the theater.

(d) The CSM is thus a table-driven computation which uses factoring techniques to distribute casualties to prespecified degrees of stratification. Its inputs are:

1. Gross casualties to be stratified by type of casualty. This data is available from the CEM, FASTALS, and the PFM.

2. Vulnerability data by category and three-digit MOS. This input is supplied by the Soldier Support Center and is updated periodically for major studies. A particular trooplist, specifying the number of entries and their zonal locations as a function of time, and a scenario are used as the data for the vulnerability calculations. Vulnerability data is updated for major studies, such as TAA and OMNIBUS.

3. Density profiles by three-digit MOS, grade, and category. This is calculated from the study trooplist and the CAA TOE data base.

(2) Special Applications

(a) The CSM was initially used by CAA to provide analytical support to the Wartime Manpower Planning System (WARMAPS) FY 85-89 Study. However, stratification has become a regular part of the OMNIBUS Study. The purpose of WARMAPS is to assess military and civilian manpower time-phased personnel requirements for the near and out-year POM requirements. For this particular study, casualties were stratified into enlisted and officer/warrant officer categories for combat, medical, and "other" career management fields, and the type of casualty:

- K/CMIA - killed, captured, or missing in action
- WIA - wounded in action
- DNBI - disease and other nonbattle injuries
- EVAC (WIA) - CONUS evacuees (WIA)
- EVAC (DNBI) - CONUS evacuees (DNBI)
- RTD (DNBI) - returns to duty (DNBI)
- RTD (WIA) - returns to duty (WIA)
- DIH (DNBI) - deaths in hospital (DNBI)
- DIH (WIA) - deaths in hospital (WIA)
- PAT REM - patients remaining in hospital

(b) For the OMNIBUS studies, casualties are stratified by three-digit MOS and grade. Casualties are a rollup of K/CMIA and hospital admissions due to WIA and DNBI, less the theater RTD.

5. SUMMARY. The purpose of this section is to summarize the key parts of the casualty estimation process and to identify strengths, limitations, and ongoing actions which will influence CAA's capability to provide estimates in the future.

a. Casualty Estimation Process. Figure 6 provides a diagram of the CAA personnel casualty estimation process.

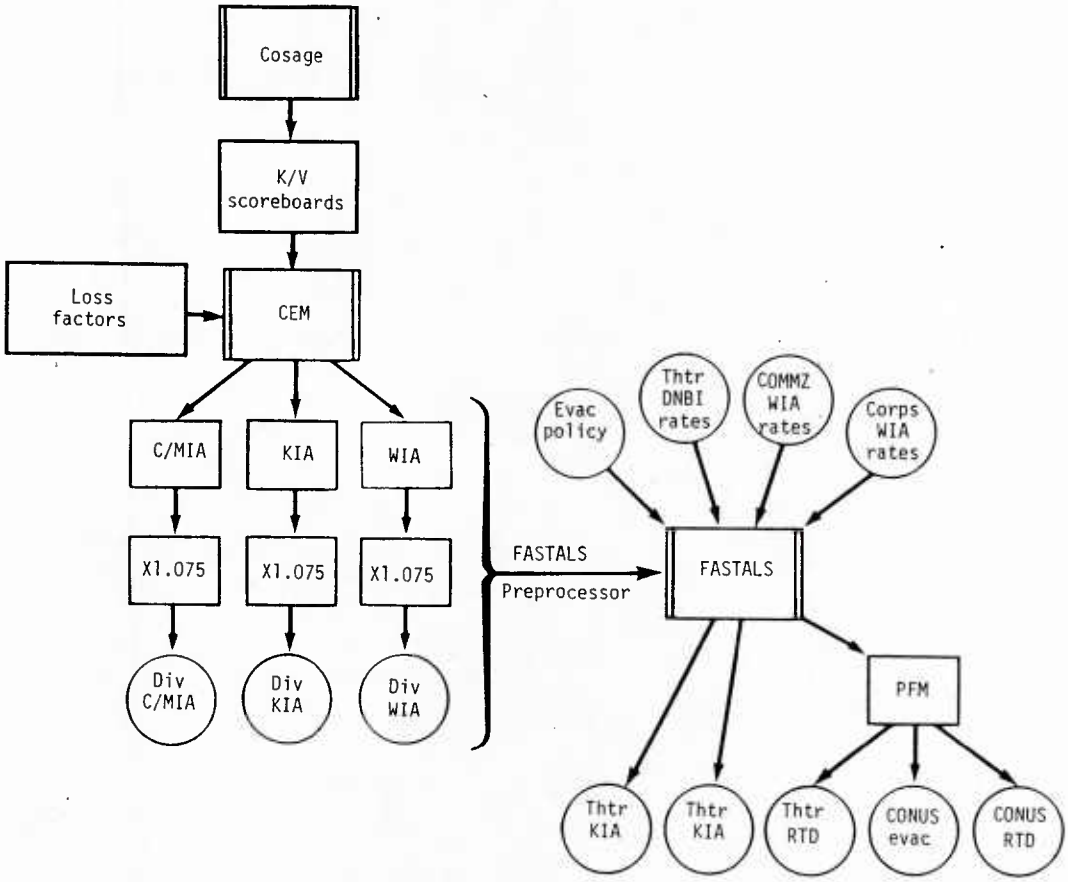

Figure 6. Summary of CAA Personnel Casualty Estimation

b. Model Inputs. Table 5 provides a summary of selected model inputs and their sources used in CAA casualty estimation methodology.

Table 5. Summary of Selected Data Inputs

Input	Model	Variance	Source
	Division		
Pers vulnerability factors	COSAGE	Weapons systems	AMSAA/BRL
WIA (totals)	CEM	Dynamic engagement	COSAGE/ FM 101-10-1
KCM (totals)	CEM	Dynamic engagement	COSAGE/ FM 101-10-1
C/MIA (totals)	CEM	Dynamic engagement	COSAGE/ FM 101-10-1
DNBI (rate)	FASTALS	Time/theater	OTSG
	Corps/COMMZ		
WIA (rate)	FASTALS/PFM	Time	AFPDA/DCSOPS
KCM (rate)	FASTALS	Time	FM 101-10-1
C/MIA	None	--	--
DNBI (rate)	FASTALS	Time	OTSG
Accumulation/disposition factor	FASTALS/PFM	Time/echelon	OTSG

c. Strengths. The principal strength of the methodology is that it represents the dynamic interaction of a large number of variables on a theater level over time. For a Central European scenario, it represents US, non-US NATO, and the Warsaw Pact

(1) Forces in combat and their attrition.

(2) Brigade size battles in each 12-hour period.

(3) Personnel at risk by echelon.

(4) Combat skills at risk.

(5) Weapons on the battlefield.

(6) Reduced unit capability from sustained losses (state).

(7) Effects of terrain.

(8) Force sustainability.

(a) Reinforcement.

(b) Resupply (personnel, equipment, ammunition).

(c) Medical capability and policies.

(d) Repair of combat vehicles.

(e) Time-phased population growth in theater.

(9) The methodology is sensitive to theater level resources and assumptions. It provides a basis for comparing different plans and resource distributions.

(10) Methodology is flexible and can accommodate different scenarios.

d. Limitations

(1) The model simulates conventional combat only. Nuclear, chemical, and biological effects are not considered.

(2) Current model (CEM) does not warfight the rear area.

(3) The current model does not simulate communications, leadership, morale, training, and combat experience.

(4) General support artillery units do not sustain combat casualties.

(5) Crew personnel are not subject to becoming captured or missing in action.

(6) PFM data base may overstate theater hospital bed requirements for certain evacuation policies because patients are held in the hospital longer than the minimum prior to evacuation.

(7) Casualties are computed without regard to tactical success or failure.

(8) Losses due to strategic deployment need better resolution.

(9) The current edition of FM 101-10-1 is old and should be reviewed and updated.

e. **Improvements.** Ongoing actions are underway which will improve the CAA casualty estimation process and include:

(1) The Force Evaluation Model (FORCEM) will add the following capabilities:

(a) Integrated warfare (IW) capability.

(b) Warfight will be carried out in the rear area.

(c) General support artillery will be played.

(2) The Improved Casualty Estimation and Evacuation System (ICEES), when completed, will incorporate the evacuation delay factor methodology of the JCS Joint Operations Planning System (JOPS) Medical Planning Module into the PFM. This will allow the user to input the time required to stabilize a patient before evacuation.

APPENDIX A

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APPENDIX B

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GLOSSARY

AFPDA	Army Force Planning Data and Assumptions (study)
AD	accumulation and disposition factor
AMSAA	US Army Materiel Systems Analysis Agency
ATCAL	attrition model using calibrated parameters
BRL	Ballistics Research Laboratory
CAA	US Army Concepts Analysis Agency
CEM	Concepts Evaluation Model
CMIA	captured or missing in action
COMMZ	communications zone
COSAGE	Combat Sample Generator
CSM	Casualty Stratification Model
D	D-day
DIH	died in hospital
DNBI	diseased, nonbattle injury
FASTALS	Force Analysis Simulation of Theater Administative and Logistic Support Model
FEBA	forward edge of the battle area
FM	field manual
FORCEM	Force Evaluation Model
HQDA	Headquarters, Department of the Army
ICEES	Improved Casualty Estimation and Evacuation System (study)
IW	integrated warfare
JCS	Joint Chiefs of Staff

JOPS	Joint Operations Planning System
K/CMIA	killed/captured or missing in action
KIA	killed in action
K/V	killer/victim
MIA	missing in action
MOS	military occupational specialty
NATO	North Atlantic Treaty Organization
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
ODCSPER	Office of the Deputy Chief of Staff for Personnel
OTSG	Office of The Surgeon General
PFM	Patient Flow Model
RIH	remaining in hospital
RTD	return to duty
SSPK	single shot probability of kill
TAA	Total Army Analysis (study)
TOE	table(s) of organization and equipment
TRADOC	US Army Training and Doctrine Command
TRANSMO	Transportation Model
WIA	wounded in action