Using the TNDM for

The Battle of Singapore
INTRODUCTION

In tribute to what Trevor Dupuy pioneered and in an effort to pursue what he wanted to achieve, TDI continues to amass historical data and strives to refine the combat variables which go into the TNDM. In this issue of our newsletter Christopher Lawrence, Alex Dinsmoor, and Bill Beuttel continue to provide information on these efforts.

As you, our readers, survey the pages of this issue, you may be curious about the total scope of work of TDI. The paragraphs below outline what is missing in applied military history and what TDI is doing to shore up that deficiency. In other words, here is our core capability:

1. TDI provides independent, objective, historically–based analyses of modern military campaigns. Operations research, as developed during and right after World War II, was based on recorded, detailed data from battles. It is now nearly extinct. It has been supplanted by weapons and systems effects and performance analyses totally devoid of human factors considerations. As a result the Services, particularly the Army, have only partial answers for the development of operational concepts, battle doctrine, weapons requirements, and organizations. Similarly, because they were not historically validated, the Service models and simulations are skewed. Striving for only measured weapons effects and technical systems capabilities, they miss (or significantly distort) the impact of leadership, training, organization, and psychological factors (such as fear of death) on military units in contact.

2. Over the years, TDI, a successor organization to the Historical Evaluation and Research Organization (HERO), both founded by the late Col. Trevor N. Dupuy, has compiled a large database from modern military campaigns and battles. Using Colonel Dupuy’s methodologies and some new techniques, TDI has developed the following capabilities:

   a. Comparison of fighting capabilities of opposing forces (systemic strengths and weaknesses) based on:
      (1) Command and organizational arrangements, leadership, force structure, intelligence, and logistics;
      (2) Training, cultural and psychological profiles, and flow of information;
      (3) Doctrinal flexibility or constraints in utilizing new weapons and technologies.

   b. Validation of models or simulations and of scenarios for field exercises. Validation is a process, based on historical data and trends, that assists in determining whether a scenario, model, or simulation is an accurate representation of the real world. TDI has the capability to do this independently or to provide primary source historical data for agency in–house validations.

   c. Estimating casualties for combat or other operations.

   d. Providing lessons learned from studies of cause and effect chains among responsible players at the political, theater, operational, and tactical levels.

   e. Analysis of group behavior (impact of various combat activities on units) and other human factors (historically–based aggregate measure of leadership, training, morale, organizational capacity, and cultural characteristics) in modern battles.

   f. Studies, based on historic trends and experiential data, of the specific impact on combat caused by new technology and the improvement in weapons. This enables projections of ways in which future wars should be fought and understanding of what elements constitute “force multipliers.”

3. The capabilities listed above merge operations research with historical trends, actual combat data, and real world perspectives creating applied military history in its most useful sense.
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In honor of the memory of the late
Trevor N. Dupuy
Col., USA

Summer 2009
From the Editor...

The last issue of The International TNDM Newsletter was published in December 1998. The ten-year gap in publication was because of relatively limited work on the model during most of that period. Still, not all was quiet here at The Dupuy Institute (TDI) during that period.

This newsletter has come about due to TDI having made a sale recently in Asia, and this generated a desire by us to make some additional changes to the model. During the ten-year publication gap, we sold a copy of the model, without a support contract, to a country in Europe. We also performed two major contractual efforts that used the TNDM. First, we prepared an extensive report for the Army Medical Department in 2005 that compared the TNDM to five other casualty-estimation methodologies, reviewed the bases for various casualty estimation methodologies and models, and prepared a computerized catalog of over 150 combat models and casualty-estimation methodologies. Part of that report will be presented in this newsletter. The article “Comparing Force Ratios to Casualty Exchange Ratios” is an appendix from that report.

The other major effort was the use of the TNDM in 2006 to analyze the potential effectiveness of a projected combat system as compared to historical data. In this case, we ran a series of corps-level and division-level engagements from the Battle of Kursk (July 1943) using the TNDM. The results of these runs, which basically serve as an independent and separate corps- and division-level validation of the model, will be published in our next newsletter.

So, there has been some use of the model in the decade since our last publication. On the other hand, since 2004, most our work at the Institute has been focused on insurgencies. While this is not related in any manner to our TNDM work (although this was not entirely the case for the Bosnia estimate done in 1995), it is work that we feel is of interest to many of our readers. Therefore, I have included a copy of an article called “The Analysis of the Historical Effectiveness of Different Counterinsurgency Tactics and Strategies.” This was work drawn from an effort we completed last year and was presented for us in 2008 by Gene Visco at the Cornwallis Group. As such, this same article appears in the Proceedings of the 2008 Cornwallis Group that is expected to be published this spring.

The lead article in this newsletter comes from a sample use of the model that we recently did in preparation for our sale of the TNDM in Asia. The article on the analysis of the morale table in the TNDM was also prepared in response to questions from our new customer. They were both written by one of our junior researchers, Alexander Dinsmoor, who is profiled in the “Who is TDI” section.

The remaining article is the third and second-to-last installment in the series of articles by H. W. Beuttel on the Iran-Iraq War. The first two articles appeared in Volume II, Numbers 3 and 4 of the newsletter. This article on chemical warfare has been sitting in our files for a decade, awaiting publication. It was time to complete that, and Bill Beuttel graciously took the time to update the article before we published it here. The next issue will present his revised summation of casualties in the Iran-Iraq War.
This completes the return of The International TNDM Newsletter. We intend to publish quarterly over the next year and already have enough material assembled to cover the next year. If we decide to talk insurgencies, which have been the primary focus of our work for the last four-and-a-half years, then we can certainly fill many more newsletters.

The TNDM is currently being reviewed, and we expect soon to complete another round of revisions, creating version 2.07. This will include fixing some minor computer bugs and clean-up. We then intend to revise the model to better address the effects of fighting in urban terrain, based upon the work we did in our three urban warfare studies.

Anyhow, it’s good to be back and good to bring the newsletter back to life.
Introduction

On December 8, 1941, forces of imperial Japan attacked British forces on the northeastern coast of the Malayan Peninsula at Kota Bharu. Additional Japanese forces landed in Thailand and proceeded overland into western Malaya. The British forces in Malaya were undermanned and under-trained and quickly fell back. The Japanese forces advanced down the coasts and the central trunk road toward Singapore Island.

The British pursued both a land- and sea-based defensive strategy. The land forces deployed throughout the Malaya Peninsula were too few to cover the whole peninsula and too dispersed to support each other. The naval strategy was based on a deterrent force consisting of the battle cruiser HMS Repulse, the battleship HMS Prince of Wales, and four destroyers. It was thought that the two capital ships would be a powerful disincentive to any Japanese attack. Both strategies failed. The Japanese were able to land on the peninsula without difficulty and sank both capital ships with aircraft attacks on December 10, 1941. By early February 1942, the British had been pushed all the way back to Singapore. The only barrier between the Japanese and Singapore was the Jahore Strait, separating Malaya from Singapore Island. The Japanese possessed air superiority from the beginning of the campaign through its conclusion with the fall of Singapore.

This article describes the Japanese assault crossing of the strait – the Battle of Sarimbun Beach – as analyzed using the TNDM.

Japanese Forces

The Japanese deployed their 25th Army, under the command of Gen. Tomoyuki Yamashita, to Malaya. The 25th Army was composed of the 5th Division, the 18th Division and the Imperial Guards Division. All three divisions were veteran, having had combat experience in China. Additionally, prior to crossing the Jahore Strait, the Japanese occupied overwatch positions in Jahore, giving them an excellent view of the strait.

After pushing the British out of Malaya, the three divisions lined up along the shore of the Jahore Strait opposite Singapore. The 5th and 18th divisions deployed in the west, facing to the southeast, with the 5th on the right and the 18th on the left. The Imperial Guards Division was in position along the coast to the east of the 5th and 18th divisions, covering most of the strait from just west of the causeway to opposite Palau Ubin. The Japanese forces had sufficient boats to transport their forces across the strait and into Singapore. Furthermore, the Japanese had either practiced with boats or had river-crossing experience during operations in China.

For the TNDM analysis, we have given the Japanese 13 infantry battalions and 2 divisional artillery support units. Japanese reports indicate that they had a total of 13 battalions available for the attack, with 5 in reserve. The opposing Australians estimated that as many as 12 battalions could have crossed the strait by noon on February 9.

British Empire Forces

Lt. Gen. Arthur Earnest Percival was the General Officer Commanding (GOC) of the Malaya Command, which was responsible for defending the Malayan Peninsula and Singapore. The Malaya Command’s principal formation was the Indian III Corps, which consisted of the 9th Indian and 11th Indian divisions and the 8th Australian Division, with the 28th Indian Brigade in reserve. By the time these forces had withdrawn to Singapore Island, they had been reduced in numbers and capability. The forces remaining intact for the defense of Singapore included: the 11th Indian Division, the 8th Australian Division, the newly-arrived 18th British Division, several surviving Indian brigades, 2 Malaya brigades, the Straits Settlements Volunteer Force (brigade-sized), and several smaller locally-raised militias. Most of these forces were depleted in strength, although several of them had just received replacements.

Singapore Island was home to a major Royal Navy base at Sembawang. Batteries of coastal defense guns were placed around the island to defend the base from a
naval attack. Contrary to popular belief, the guns were capable of aiming landward; however, their armament consisted almost entirely of armor piercing shells intended for use against ships. Much of the base infrastructure had been destroyed prior to the Japanese attack on Singapore Island.

Singapore Island contained several airfields. The most significant was Tengah airfield, which was the Japanese objective on the first day of the attack. After the British withdrawal to Singapore Island, Tengah airfield was in range of Japanese artillery, causing the British aircraft to be relocated to Kallang airfield. After the initial landing on the night of February 8th, the surviving aircraft withdrew to Sumatra. After the initial landing on the night of February 8th, the surviving aircraft withdrew to Sumatra. Close to the end of the Malaya campaign, the defending Brewster Buffalos, which had proven no match for the Japanese aircraft, were reinforced by Hurricanes.

After withdrawing across the Johore Strait, the British forces redeployed to defend Singapore Island. The northern coast was divided into eastern and western defense areas. The 8th Australian Division was given responsibility for the western defense area, which ran up the west coast to just east of the causeway. The Indian III Corps, then consisting of the 11th Indian Division and the 18th British Division, was given the responsibility for the eastern defense area, which started just east of the causeway and ran along the entire northeastern coast. The two Malay brigades, the Straits Settlements Volunteer Force and some Indian units were in reserve along the southern coast and in the city of Singapore.

The Sarimbun Beach area, where the Japanese were planning their main effort, was defended by the Australian 22nd Brigade, facing northwest, under the command of Brig. Harold B. Taylor. The Australian 27th Brigade was on the 22nd Brigade’s right flank in Kranji. The 44th Indian Brigade was on the 22nd Brigade’s left, south of the Choa Chu Kang road. The 22nd Brigade had received replacements after suffering casualties during the fighting in Malaya, but they were poorly trained. The 22nd Brigade was responsible for covering almost 8 km of coastline against 2 veteran Japanese divisions.

The 22nd Brigade deployed with the 2/19 Battalion on the left, the 2/18 Battalion in the center and the 2/20 Battalion on the right. The 22nd Brigade was supported by D Company of the 2/4 Machine Gun Battalion, the 2/15 Field Regiment (minus 1 battery), G Troop (a provisional artillery unit) and 100 men from Dalforce, a Malay militia unit armed with rifles. The forward posts were equipped with searchlights, which, with a single exception, were not used during the battle, and Very lights (flare guns) to signal their supporting artillery.

The engagement ended at 0630 hrs on February 9th, when the 2/29th Battalion (27th Brigade) arrived in the vicinity of Tengah Airfield. The 2/29th Battalion had been ordered into the 22nd Brigade’s zone but took several hours to concentrate its forces before moving west. If the engagement were to be continued beyond this point, other reinforcing units, which began showing up on the morning of February 9th, would have to be added.

The Battle of Sarimbun Beach

Following an artillery bombardment, the first wave of Japanese assault troops crossed the Johore strait at approximately 2230 hrs. February 8, 1942. Col. Arthur Varley, commander of the 2/18 Battalion, had ordered his troops to be prepared for a night attack, as had been Japanese custom throughout the Malaya campaign. The Japanese crossed the straits in small boats, each carrying 20-25 men. Where the boats ran into defending forces they were shot-up, but the defenders were spread thinly over their 8 km front, allowing many boats to land unopposed. The Japanese mounted machine guns
and mortars on barges that followed the attacking force to provide close support.

Once ashore the Japanese force utilized the infiltration tactics they had used so effectively on the peninsula. When they encountered an opposing force, they would pin it with a small detachment and send most of their troops on a flanking maneuver. These tactics were particularly effective at night, when visibility was low. The Japanese preparatory bombardment had not caused many casualties but had damaged the communications lines. Most of the Australian forces lacked radios, as they had been turned over for maintenance after the retreat from Malaya and had not been properly redistributed. It is not clear if the supporting artillery units were able to see the Very lights that the front line troops had been equipped with for signaling. The Very lights were, however, visible to troops in the neighboring 27th Brigade.

The Japanese attack fell most heavily on the 2/18th Battalion in the center of the 22nd Brigade’s line. On the 2/18th’s right, “A” Company, and on the left, “C” Company, were the targets of landings. The Japanese forces worked their way up the Sungei Sarimbun and the Sungei Murai, (both small rivers) on the right and left flanks of the 2/18th Battalion. Many of the Australian units that were not surrounded or dispersed put up a fight until 0100 or 0200 hrs, when they began to run low on ammunition. By 0130 on the 9th, Varley requested approval for a withdrawal to Ama Keng. One of the Australian’s fall-back plans had been to establish a defensive line from the village of Ama Keng to the Sungei Berih, however, no work was ever done on the position. Under the weight of continuing Japanese attacks, the Australian line was never reestablished. Communications quickly broke down during the retreat, and scattered Australian forces withdrew towards Tengah. The British forces never recovered, and Percival, facing a shortage of water, supplies and ammunition, surrendered to Yamashita on February 15, 1942, days after the battle of Sarimbun Beach.

Running the Battle in the TNDM

In order to run the battle in the TNDM we created a Japanese battalion based on a TO&E from a World War II US government information packet. Each battalion had 1,100 troops. We gave each battalion 2 70mm bn guns, 36 Type 11 LMGs, 12 Type 92 HMGs, 12 50mm “Knee Mortars,” 2 90mm mortars and 1,036 Arisaka rifles. The Japanese were given 13 of these battalions for this engagement. The Japanese were also given two 2,300-man divisional artillery support units. These units represent the artillery support that would be provided by the 5th and 18th divisions’ supporting artillery. Each supporting artillery unit was given 36 75mm field guns, 12 75mm mountain guns and 12 32mm AT Guns. Based on the superior leadership, training, experience and morale that the Japanese forces had exhibited during the Malaya campaign, they were given a CEV of 2.

The same procedure was used for creating the Australian forces in the TNDM. An Australian infantry battalion, with a strength of 860 men, represents the 2/18, 2/19, and 2/20 battalions of the 22nd Brigade. The Australian forces were armed based on a TO&E of early-war Australian forces and from the Australian War Memorial’s narrative of the engagement. The Australian battalion was given 36 Bren guns, 6 3-in mortars and 818 Lee-Enfield rifles. The Australians were given the 12 motorcycles and 8 trucks they were assigned. The actual number may have been lower. Australian infantry battalions usually had 19 universal carriers; however, in light of a general lack of materiel, the total number of universal carriers assigned to all Australian forces in the battle has been reduced to 20. D Company of the 2/4 Machine Gun Battalion was assigned to support the 22nd Brigade’s three battalions. D Company’s strength was estimated at 235, and it was given 16 Vickers MMGs and 216 Lee Enfields. The 2/15 Field Regiment was assigned to provide artillery support to the 22nd Brigade. The 2/15 Field Regiment’s strength was estimated at 400. The 2/15 Field Regiment was down one battery and only had 16 Ordnance QF 25-pounders. G Troop was a provisional artillery support unit. G Troop’s strength was estimated at 400, and it was armed with 6 4.5-in. howitzers. Both artillery units were given trucks. The final unit in the 22nd Brigade’s sector was a 100-man detachment from Dalforce, a locally-raised Malay militia unit armed with rifles.

Since the Japanese were crossing the Jahore Strait, shoreline vulnerability was applied. This likely impacted the TNDM run, as the strait was not only not fordable but also is the largest size category of river or water short of an amphibious landing. Where the 5th and 18th divisions crossed, the strait was over 500 meters wide. Also, since the Japanese crossed the river in small boats were not able to bring any mechanized transport,
they have had their trucks removed. The road quality has been given as poor, and the road density has been given as sparse. This decision was based narratives of the battle and a look at maps of the area.

Results from the TNDM

The TNDM clearly has no difficulty identifying the winner when two Japanese divisions attack one Australian brigade. On the whole the losses given (about 330 for the Japanese and about 400 for the Australians) seem within the range of possibility. We do not have good casualty data for this engagement at this time.

The TNDM had difficulty accurately predicting the advance rate of the Japanese forces. In the TNDM the Japanese advance 0.817km for the engagement. Historically, they advanced at least 5 km by 0630 to near the northern edge of the Tengah airfield. Also, historically, the Japanese advanced and captured the Tengah airfield, which is approximately 6 km from the coast, within 24 hours of the landing. A number of different variables were adjusted in the TNDM for the sake of seeing whether the Japanese advance rate could reach its historical level. The two key issues are the river crossing and the lack of trucks, both of which slow the advance rate in the model. Throughout the Malaya campaign the Japanese forces had trucks. However, as previously mentioned, during the Battle of Sarimbun Beach, the Japanese were conducting a river crossing in small boats and barges and would not have been able to use their trucks. Japanese wheeled and tracked vehicles were not brought across the J cops Strait until the next day, when the Imperial Guard Division secured the causeway. Trucks and other vehicles significantly affect advance rates in the TNDM.

The TNDM had difficulty predicting artillery losses for the engagement. Japanese artillery losses for the engagement are unknown, and the TNDM did not predict any losses for the Japanese towed artillery. The TNDM predicted that the Australian’s would lose one gun. However, the 2/15 Field Regiment’s 29th Battery lost seven of its guns when the unit became bogged down during its withdrawal. Since the TNDM-predicted penetration of the Japanese was less than one kilometer, the model could not have predicted the abandonment of guns during the historical deep penetration. Concerning other materiel losses, the model predicted that the Australians would only lose three trucks; they probably lost more.

Concerning other operational or environmental factors, the fighting occurred at night during and after the initial crossing. We have the engagement ending at 0630 on the 9th, when the 2/29th Battalion (historically) arrived in the vicinity of the airfield. Neither side has been given the advantage of surprise; not only was there a preparatory bombardment before the attack started, but Colonel Varley, commander of the 2/18th Battalion ordered his troops to be prepared for a night crossing. The weather and climate have been adjusted for the fact that Singapore is 85 miles north of the equator. Terrain is a matter of contention; in the end rolling-gentle-mixed was used.

Weapons system totals for each side:

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<th>Australia</th>
<th>Japan</th>
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<tr>
<td>3,715 personnel</td>
<td>18,900 personnel</td>
</tr>
<tr>
<td>2,773 Lee-Enfield rifles</td>
<td>13,468 Ariska rifles</td>
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<tr>
<td>108 Bren guns</td>
<td>468 Type 11 LMG</td>
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<tr>
<td>16 Vickers MMG</td>
<td>156 Type 92 HMG</td>
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<tr>
<td>18 3-inch mortars</td>
<td>156 50mm mortars</td>
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<tr>
<td>20 Bren carriers</td>
<td>26 90mm mortars</td>
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<tr>
<td>6 4.5-inch howitzers</td>
<td>12 32mm AT guns</td>
</tr>
<tr>
<td>16 QF 25-pounders</td>
<td>26 70mm battalion guns</td>
</tr>
<tr>
<td>26 motorcycles</td>
<td>24 75mm mountain guns</td>
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<tr>
<td>50 trucks</td>
<td>72 75mm field guns</td>
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The TNDM report is reprinted on the following pages.
ENGAGEMENT FILENAME: SARIMBUN       ANALYST: AWD
ENGAGEMENT DESCRIPTION: Battle of Sarimbun Beach
STARTING DATE OF ENGAGEMENT: 02/08/1942
STARTING TIME OF ENGAGEMENT: 2230
ATTACKER: Japan
DEFENDER: Australia
ATTACKER’S STARTING POINT (X, Y): 0.00, 0.00
ATTACKER’S OBJECTIVE (X, Y): 0.00, 6.00

RESULTS SUMMARY

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<td>% CASUALTIES/DAY</td>
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PROGRAM-CONTROL VARIABLES

TIME STEP FOR ATTRITION CALCULATION: 8.0000 HOURS
TIME STEP FOR PRINT OUT OF RESULTS: 8.0000 HOURS MAXIMUM
ELAPSED TIME FOR SIMULATED COMBAT ENGAGEMENT: 8.0000 HOURS
INTERMEDIATE RESULTS WILL NOT BE PRINTED OUT

INPUT DATA

ENVIRONMENTAL VARIABLES

LIGHTING LEVEL: MIXED DAY AND NIGHT, HALF DAY
TERRAIN TYPE: ROLLING-GENTLE-MIXED
WEATHER CONDITION: DRY-SUNSHINE-EXTREME HEAT
CLIMATE/SEASON OF YEAR: SEMI-TROPICAL
ROAD QUALITY: POOR ROADS
ROAD DENSITY: SPARSE

OPERATIONAL VARIABLES

ATTACKER’S MISSION: ATTACK (MAIN EFFORT)
DEFENDER’S MISSION: HASTY DEFENSE
ATTACKER’S WEAPONS SOPHISTICATION: UNKNOWN
DEFENDER’S WEAPONS SOPHISTICATION: UNKNOWN
FORCE TYPE: INFANTRY
ATTACKER HAS AIR SUPERIORITY
SURPRISE LEVEL: NO SURPRISE
PRIOR DAYS OF COMBAT - ATTACKER: 0.00
PRIOR DAYS OF COMBAT - DEFENDER: 0.00

SHORELINE VULNERABILITY
WATER/BEACH OBSTACLE: ACROSS MAJOR UNFORDABLE RIVER
FRIENDLY TROOPS DISTANCE FROM SHORE: Less than 1,000m (small arms fire)
WIDTH OF UNFORDABLE RIVER/STREAM: 5 = 500 METERS OR MORE
ATTACKER CEV: 2.000

EQUATION MODIFIERS
ATTACKER DEFENDER
COMBAT POWER: 1.000 1.000
ATTRITION RATE: 1.000 1.000
TOWED ARTILLERY RATE: 1.000 1.000
SP ARTILLERY RATE: 1.000 1.000
ADVANCE RATE: 1.000
SET PIECE FACTORS: 1.000 1.000

Original Dispersion Factors
ATTACKER DEFENDER
3000.000 3000.000

New Dispersion Factors
3000.000 3000.000

ATTACKER’S ORDER OF BATTLE
13.000 Infantry Battalion of JAPAN
2.000 Divisional Artillery of JAPAN

DEFENDER’S ORDER OF BATTLE
3.000 Infantry Battalion of AUSTRALIA
1.000 D Coy 2/4 Machine Gun BN of AUSTRALIA
1.000 2/15 Field Regiment (-1 Bty) of AUSTRALIA
1.000 G Troop Provisional of AUSTRALIA
1.000 Dalforce of AUSTRALIA

FORCE & EQUIPMENT INVENTORY
ATTACKER DEFENDER
NUMBER OF PERSONNEL 18900 3715

NUMBERS OF COMBAT SYSTEMS
ATTACKER DEFENDER SCORES
Armor 0 20 0.000 3.200
Infantry 14274 2915 9765.028 2016.229
Anti-Tank 24 0 696.000 0.000
Towed Artillery 122 22 10616.000 654.000
SP Artillery 0 0 0.000 0.000
Anti-Air 0 0 0.000 0.000
Fixed-Wing Aircraft 0 0 0.000 0.000
Rotary-Wing Aircraft 0 0 0.000 0.000
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<td>Fixed-Wing Aircraft</td>
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<td>TOTAL OLI</td>
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<td>5332</td>
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**SNAPSHOT OF BATTLEFIELD OUTCOME AFTER 8.000 HOURS OF COMBAT**

(1 TIME STEP OF CALCULATION)

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<tr>
<td>Infantry</td>
<td>9592</td>
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<tr>
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<tr>
<td>TOTAL OLI</td>
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**NUMBERS OF MOBILITY ELEMENTS**

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<td>Fixed-Wing Aircraft</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Rotary-Wing Aircraft</td>
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<td>0</td>
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<tr>
<td>Motorcycles</td>
<td>0</td>
<td>34</td>
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</tbody>
</table>
Analysis of the Historical Effectiveness of Different Counterinsurgency Tactics and Strategies

Christopher A. Lawrence

Background

In 1990, Trevor N. Dupuy, using his combat model, the TNDM (Tactical Numerical Deterministic Model) made casualty predictions about the upcoming Gulf War, both in congressional testimony and in a book published just before the shooting started in Kuwait in 1991. His estimate was the lowest public estimate presented and, therefore, more accurate than the much higher estimates provided by the US defense community.

Subsequently, in 1995, The Dupuy Institute assembled an estimate of casualties for the chairman of the Joint Staff before the US decision to deploy into Bosnia. This was the first systematic attempt we are aware of to provide a casualty estimate for what was then called Operations Other than War (OOTW—a term no longer employed). The estimate was derived from analysis of a database of 90 peacekeeping operations, insurgencies and interventions that we had assembled. It provided an accurate prediction and, in this case, became part of the decision-making process.

In late 2004, The Dupuy Institute provided projections of casualties, duration and several other factors for the developing insurgency in Iraq. This was the first systematic attempt we are aware of to provide casualty and duration estimates for an insurgency. It was derived from a database of 28 post-World War II insurgencies that we had assembled. Like the Bosnia estimate, it was accurate in its predictions of casualties, and provided predictions on duration, US force size, insurgent force size and other factors. As such, it stands today, four years later, without change.

Counterinsurgency Tactics and Strategy Study

This study was a direct consequence and partial continuation of the Casualty Estimate for the Insurgency in Iraq study done by The Dupuy Institute in 2004. With a more extensive database of 83 insurgencies, interventions and peacekeeping operations, we began systematically to test the theories of various counterinsurgency experts. The effort included an examination of the works of nine experts: Clutterbuck, Galula, Joes, Kitson, Fall, Manwaring, O’Neill, Trinquier and a 1984 BDM report.

As part of this study, we systematically examined the published works of these nine theorists and summarized their conclusions. We then compared the results of the analysis of our database to these theorists’ conclusions to see if the data supported or contradicted their hypotheses. In those areas where we were able to test their ideas (and there were limitations), we were only able to find support for about half of what they had hypothesized, with the exception of David Galula and Bernard Fall, for whom we found broad support.

This effort included a broad range of findings based upon a statistically measurable and significant number of cases from our database of 83 post-WWII cases. The analysis of these issues and the data used in the analysis are included in a series of detailed appendices to the full report, or as separate referenced reports, but are not included in this brief summary of our work. Our findings addressed:

• Terrain
• Rules of Engagement and Degrees of Brutality
• Nature of Insurgencies
• Force Ratios
• Measurements of Burden
• Operational Details - Active Sanctuaries, Border Controls and Population Resettlement
• Indigenous Government Type and Elections
• Force Ratio versus Cause

Conclusions

Our principal conclusion from this exercise is that Force Ratios and Insurgent Cause are extremely significant factors. We can build a model based on these two fac-

1 The Dupuy Institute, Casualty Estimate for the Insurgency in Iraq - Draft. Annandale, VA: The Dupuy Institute, 2005. This was presented as a series of briefings given between December 2004 and March 2005 and included an undistributed draft paper.
tors alone that will explain the outcome of 80% of the 83 cases we examined. This is quantitative analysis of the largest and most detailed insurgency database that we are aware of. This does not mean we are convinced that it is entirely correct, but we will argue that it has at least as much support as any other suggestions made and more support than most. Still, it is clear that more work needs to be done.

In general, Galula and Fall provide the two theoretical constructs we examined that we believe have a sound basis.

We also conclude that:

1) There is a strong need for further study of these issues.
2) There is a considerable danger of negative learning.
3) There is not a strong basis for developing any model of insurgency before further study is conducted.
4) There are sometimes limitations with developing theories based primarily upon personal experience.

The Big Picture

1) Force ratios, within reason, are not an issue when facing regional or factional insurgencies.
2) When facing insurgencies that have a broad base of support, one needs at least a 5-to-1 force ratio and preferably a 10-to-1 force ratio.
3) It appears that the two most important factors in determining the outcome of an insurgency are the force ratio and the nature of the cause of the insurgency.

Other Factors Tested

A number of factors were tested in this effort and in our work for the Center for Army Analysis. A listing of the important ones, but of lesser importance than force ratio and cause of insurgency, are provided below. Once the two most important factors are addressed, then other lower order factors come into play. The lower order factors include:

1) Rules of Engagement and Rectitude

Factors that may be important are the Insurgent Strategy and the impact of local government types and elections.

Then there are those elements of an insurgency that so far have not shown to be as important as those above, relatively. This does not mean that they are not important; it just means that their impact appears to be of a lower order in the overall picture. These include:

1) Structure of Insurgencies
2) Specific Government Reforms
3) Degree of Outside Support
4) Sanctuary
5) Barrier Systems
6) Population Resettlement
7) Government Type
8) Staying the Course

Recommendations

1. Future analysis should be focused to address one of three distinct time frames:
   a. Before an insurgency starts (pre-insurgency)
   b. The early stages of an insurgency (proto-insurgency)
   c. An insurgency that has clearly developed (developed insurgency)

   Our current work addresses primarily developed insurgencies.

2. The intelligence community needs three sets of quantitative predictive tools. These are not intended to replace current approaches but to supplement them. The three sets of tools are:

   a. A model that predicts the chances of political violence across all nations. This is, in effect, readdressing the Gurr and Feierabend & Feierabend work and would be extended to address all the data that has accumulated in the 40 years since they did their analysis. This is not a small effort (pre-insurgency model).

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2 Burden in this case refers to the cost of the war, measured as either a percent of losses compared to home population (what we label intensity), or a percent of forces committed compared to the home population (what we label commitment).
b. A model or set of procedures that predicts the chances of and analyzes the nature of insurgencies in their early stages (proto-insurgency model).

c. A model or set of procedures that predicts the chances of and analyzes the nature of insurgencies that are clearly developing. This is effectively what our Iraq casualty estimate did in January 2005 (developed insurgency model).

3. Training tools need to be revamped to consider current understandings and to remove past biases.

   a. The political concept, motivation and causes of insurgencies need to be seriously addressed.

   b. The structure of the insurgency needs to be addressed. The current material appears to be overly influenced by the US experience in Vietnam.

   c. The issue of outside support needs to be addressed. The current material appears to be overly influenced by the US experience in Vietnam.

4. Analysis needs somehow to be able to parse the study of insurgencies to their appropriate levels, from strategic concerns (most important), to operational concerns to tactics. Each level needs to be studied separately and then at some point, interrelated.

5. Related to the above points, databases need to be constructed for analytical uses that address the appropriate levels and the appropriate time frames.

6. Time series analysis looking at the changes in violence and actions over time and the events that might drive those changes needs to be done.

7. There needs to be an examination of the how to measure the degree of population control based upon real-world examples.

There are 38 additional recommendations provided in the full report of the study.

An Example

The foregoing is drawn from our reports. Below we provide the solid base of data from which this is developed.

Two of our earliest and more influential findings were that we were able to see a difference in outcomes depending on the nature of the cause of the insurgency. Those insurgencies based upon a limited developed political thought, basically a regional or factional insurgency, resulted in insurgent victories (red victories) in just 23% of our cases, while those based upon a central political idea (like nationalism or anti-colonialism) resulted in insurgent victories in 64% of our cases. The third category we worked with applied to those based upon an overarching concept, which in all of our cases was communism, but could represent any overarching ideological or religious construct.

<table>
<thead>
<tr>
<th>Outcome by Type of Political Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome</td>
</tr>
<tr>
<td>Blue</td>
</tr>
<tr>
<td>Gray</td>
</tr>
<tr>
<td>Red</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Two-sided p-value from Fisher’s exact test excluding the not applicable cases: 0.0077

Two-sided p-value Fisher’s exact test excluding the not applicable and gray cases: 0.0031

3 Basically, these Fisher Exact Tests establish that the results do not come about by chance (less than 1% chance that they did). They do not establish cause and effect.
<table>
<thead>
<tr>
<th>Name</th>
<th>Force Ratio</th>
<th>Peak Insurgent Strength</th>
<th>Years</th>
<th>Winner</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peacekeeping in Liberia (1990-1997)</td>
<td>0.38</td>
<td>31,000</td>
<td>7.11</td>
<td>Insurgents</td>
<td>INS/I</td>
</tr>
<tr>
<td>First Chechen War (1994-1996)</td>
<td>0.61</td>
<td>62,000</td>
<td>1.73</td>
<td>Insurgents</td>
<td>CONV/INS becomes INS/NI</td>
</tr>
<tr>
<td>Operation Tacaud (1978-1980)</td>
<td>0.75</td>
<td>19,400</td>
<td>2.21</td>
<td>Insurgents</td>
<td>INS/I</td>
</tr>
<tr>
<td>Tanzania in Uganda (1978-1980)</td>
<td>1.07</td>
<td>26,200</td>
<td>2.01</td>
<td>Intervening Force</td>
<td>CONV/INS becomes INS/I</td>
</tr>
<tr>
<td>Katanga Wars (1961-1963)</td>
<td>1.09</td>
<td>12,400</td>
<td>1.36</td>
<td>Intervening Force</td>
<td>CONV</td>
</tr>
<tr>
<td>UN Mission to Somalia (1992-1995)</td>
<td>1.09</td>
<td>32,000</td>
<td>2.47</td>
<td>Insurgents</td>
<td>VIOLENCE</td>
</tr>
<tr>
<td>2. Ukraine (1944-1957)</td>
<td>1.12</td>
<td>40,000</td>
<td>10.24</td>
<td>Government</td>
<td>INS/NI</td>
</tr>
<tr>
<td>Borneo (1963-1966)</td>
<td>1.25</td>
<td>22,000</td>
<td>3.34</td>
<td>Intervening Force</td>
<td>GUERINV</td>
</tr>
<tr>
<td>UN PK in Congo (2000-present)</td>
<td>1.28</td>
<td>89,250</td>
<td>7.85</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>PK Ivory Coast (2002-present)</td>
<td>1.28</td>
<td>52,564</td>
<td>5.28</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>Second PK in Liberia (2003-present)</td>
<td>1.52</td>
<td>42,604</td>
<td>4.41</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>Yemen (1962-1970)</td>
<td>1.55</td>
<td>40,000</td>
<td>7.55</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>UN PK in Yugoslavia (1992-present)</td>
<td>1.57</td>
<td>219,000</td>
<td>15.87</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>Chad Civil War (1965-1969)</td>
<td>1.60</td>
<td>5,000</td>
<td>3.42</td>
<td>Insurgents</td>
<td>INS/NI</td>
</tr>
<tr>
<td>PK in Lebanon (1990-present)</td>
<td>2.09</td>
<td>37,700</td>
<td>17.22</td>
<td>Ongoing</td>
<td>PEACE</td>
</tr>
<tr>
<td>French in Chad (1969-1971)</td>
<td>2.30</td>
<td>5,000</td>
<td>2.21</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>UN PK in Rwanda (1993-1996)</td>
<td>2.37</td>
<td>20,000</td>
<td>2.43</td>
<td>Insurgents</td>
<td>PEACE</td>
</tr>
<tr>
<td>Angola Civil War (1975-1991)</td>
<td>2.56</td>
<td>68,550</td>
<td>13.87</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>PK in Sierra Leone (1997-2005)</td>
<td>2.71</td>
<td>21,000</td>
<td>8.61</td>
<td>Intervening Force</td>
<td>CONV/INS becomes INS/I</td>
</tr>
<tr>
<td>Oman (1957-1959)</td>
<td>3.14</td>
<td>630</td>
<td>1.54</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>UN PK in Congo (1960-1964)</td>
<td>3.18</td>
<td>17,244</td>
<td>3.96</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>Uganda Civil War (1979-1986)</td>
<td>3.73</td>
<td>11,000</td>
<td>6.80</td>
<td>Insurgents</td>
<td>INS/NI</td>
</tr>
<tr>
<td>Mozambique Civil War (1976-1992)</td>
<td>4.08</td>
<td>20,000</td>
<td>16.60</td>
<td>Government</td>
<td>INS/I</td>
</tr>
<tr>
<td>US in Afghanistan (2001-present)</td>
<td>4.68</td>
<td>25,000</td>
<td>6.13</td>
<td>Ongoing</td>
<td>INS/I</td>
</tr>
<tr>
<td>Lebanon (1975-1990)</td>
<td>5.67</td>
<td>28,000</td>
<td>15.52</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>Contras in Nicaragua (1982-1990)</td>
<td>6.38</td>
<td>12,000</td>
<td>8.41</td>
<td>Government</td>
<td>INS/NI</td>
</tr>
<tr>
<td>Event</td>
<td>Force Ratio</td>
<td>Casualties</td>
<td>Duration</td>
<td>Outcome</td>
<td>Intervention</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-------------</td>
<td>------------</td>
<td>----------</td>
<td>------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>La Menos Violencia (1958-1964)</td>
<td>8.32</td>
<td>8,100</td>
<td>6.29</td>
<td>Draw</td>
<td>VIOLENCE</td>
</tr>
<tr>
<td>La Violencia (1948-1958)</td>
<td>11.23</td>
<td>6,000</td>
<td>9.85</td>
<td>Draw</td>
<td>VIOLENCE</td>
</tr>
<tr>
<td>UN PK in Mozambique (1992-1994)</td>
<td>11.79</td>
<td>20,538</td>
<td>1.98</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>Iraq (2003 - present)</td>
<td>15.39</td>
<td>27,000</td>
<td>4.79</td>
<td>Ongoing</td>
<td>CONV/INS becomes INS/I</td>
</tr>
<tr>
<td>UN PK in Burundi (2004-2006)</td>
<td>18.69</td>
<td>3,000</td>
<td>2.62</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>Kashmir (1988 - present)</td>
<td>40.00</td>
<td>10,000</td>
<td>19.43</td>
<td>Government</td>
<td>INS/NI</td>
</tr>
</tbody>
</table>

It is clear from a cursory glance, that there is not a good track record when engaged in operations against insurgent forces that outnumber you (the three cases this was tried resulted in insurgent victories). For those operations where the force ratio is between 1-to-1 and 4-to-1 the counterinsurgent usually, but not always wins. For those operations where the force ratio is above 4-to-1, there are no insurgent victories. Note: the “Peace” in the last column means peacekeeping operations, with “INS” means an insurgency of some type.

On the other hand, the picture is radically different for insurgencies based upon a central political idea: (see table, next page)
<table>
<thead>
<tr>
<th>Name</th>
<th>Force Ratio</th>
<th>Peak Insurgent Strength</th>
<th>Years</th>
<th>Winner</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Indonesia (1945-1949)</td>
<td>1.13</td>
<td>160,000</td>
<td>4.33</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>5. Indochina War (1946-1954)</td>
<td>1.28</td>
<td>350,000</td>
<td>7.67</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>42. Rhodesia II (1972-1979)</td>
<td>1.34</td>
<td>33,500</td>
<td>7.01</td>
<td>Insurgents</td>
<td>INS/I</td>
</tr>
<tr>
<td>1. UK in Palestine (1944-48)</td>
<td>1.58</td>
<td>55,500</td>
<td>4.29</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>12. Cameroun (1955-1960)</td>
<td>1.82</td>
<td>3,000</td>
<td>4.48</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>53. USSR in Afghanistan (1979-1989)</td>
<td>2.28</td>
<td>110,000</td>
<td>9.15</td>
<td>Insurgents</td>
<td>INS/I</td>
</tr>
<tr>
<td>35. Namibia (1966-1989)</td>
<td>2.84</td>
<td>14,000</td>
<td>22.68</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>17. Vietnam I (1957-1960)</td>
<td>3.52</td>
<td>75,017</td>
<td>3.40</td>
<td>Insurgents</td>
<td>INS/NI</td>
</tr>
<tr>
<td>50. Cambodia (1978-1989)</td>
<td>4.06</td>
<td>64,000</td>
<td>10.78</td>
<td>Insurgents</td>
<td>CONV/INS becomes INS/I</td>
</tr>
<tr>
<td>37. Sandinistas (1967-1979)</td>
<td>4.18</td>
<td>4,000</td>
<td>12.50</td>
<td>Insurgents</td>
<td>INS/NI</td>
</tr>
<tr>
<td>43. Polisario Rebellion (1973-1991)</td>
<td>5.71</td>
<td>21,000</td>
<td>18.34</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>9. Mau Mau Revolt (1952-1956)</td>
<td>5.97</td>
<td>12,000</td>
<td>3.44</td>
<td>Intervening Force</td>
<td>SUP/INS becomes INS/C</td>
</tr>
<tr>
<td>30. Mozambique (1964-1974)</td>
<td>7.00</td>
<td>10,000</td>
<td>9.87</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>29. Colombian Civil War (1964-present)</td>
<td>8.03</td>
<td>38,100</td>
<td>43.62</td>
<td>Government</td>
<td>INS/NI</td>
</tr>
<tr>
<td>14. Soviet Intervention in Hungary (1956)</td>
<td>8.90</td>
<td>15,000</td>
<td>0.05</td>
<td>Intervening Force</td>
<td>SUP</td>
</tr>
<tr>
<td>83. Hezbollah War (2006)</td>
<td>10.00</td>
<td>3,000</td>
<td>0.09</td>
<td>Insurgents</td>
<td>GUERINV</td>
</tr>
<tr>
<td>46. Indonesia in Timor (1975-1999)</td>
<td>10.20</td>
<td>3,000</td>
<td>24.03</td>
<td>Insurgents</td>
<td>CONV/INS becomes INS/I</td>
</tr>
<tr>
<td>10. Algerian War (1954-1962)</td>
<td>10.28</td>
<td>61,100</td>
<td>7.67</td>
<td>Insurgents</td>
<td>INS/C</td>
</tr>
<tr>
<td>58. First Intifada (1987-1993)</td>
<td>12.95</td>
<td>14,050</td>
<td>5.77</td>
<td>Insurgents</td>
<td>INS/NI</td>
</tr>
<tr>
<td>34. Rhodesia I (1966-1972)</td>
<td>15.96</td>
<td>1,360</td>
<td>6.72</td>
<td>Government</td>
<td>INS/I</td>
</tr>
<tr>
<td>11. Cyprus (1955-1959)</td>
<td>162.73</td>
<td>273</td>
<td>3.89</td>
<td>Intervening Force</td>
<td>INS/C</td>
</tr>
</tbody>
</table>
Note that in each case in which the counterinsurgents outnumbered the insurgents less than 5-to-1, the insurgents won. Counterinsurgent success improves somewhat at force ratios between 5-to-1 and 10-to-1, but only above 10-to-1 do we see a significant shift in favor of the counterinsurgent. These two charts clearly establish that both cause and size (force ratios) matter. The final chart reinforces these observations.

### Overarching Idea (like communism)

<table>
<thead>
<tr>
<th>Name</th>
<th>Force Ratio</th>
<th>Peak Insurgent Strength</th>
<th>Years</th>
<th>Winner</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>65. UN PK in Cambodia (1991-1993)</td>
<td>0.70</td>
<td>27,000</td>
<td>2.08</td>
<td>Intervening Force</td>
<td>PEACE</td>
</tr>
<tr>
<td>21. Vietnam II (1961-1964)</td>
<td>2.26</td>
<td>261,710</td>
<td>4.00</td>
<td>Insurgents</td>
<td>INS/I</td>
</tr>
<tr>
<td>31. Vietnam War (1965-1973)</td>
<td>4.32</td>
<td>376,000</td>
<td>8.08</td>
<td>Insurgents</td>
<td>INS/I</td>
</tr>
<tr>
<td>32. Dhofar Rebellion (1965-1976)</td>
<td>6.75</td>
<td>2,000</td>
<td>10.90</td>
<td>Intervening Force</td>
<td>INS/I</td>
</tr>
<tr>
<td>20. Guatemala (1960-1996)</td>
<td>9.28</td>
<td>6,000</td>
<td>36.15</td>
<td>Government</td>
<td>INS/NI</td>
</tr>
<tr>
<td>15. Cuban Revolution (1956-1959)</td>
<td>10.00</td>
<td>3,000</td>
<td>2.09</td>
<td>Insurgents</td>
<td>INS/NI</td>
</tr>
<tr>
<td>36. Guevara Guerilla Campaign (1966-1967)</td>
<td>37.41</td>
<td>54</td>
<td>0.92</td>
<td>Government</td>
<td>INS/NI</td>
</tr>
</tbody>
</table>
A Logistic Regression Model

This data can be used to develop a logistic regression model as displayed below:

Due to other priorities, the work on this effort has shifted from the big-picture analysis, and currently, no further effort is being done to refine or develop this work. We feel that this is unfortunate. We were developing useful findings that we felt had universal application across a range of irregular warfare conflicts. More work clearly is needed.

The attendees of Cornwallis should note that some of our results look similar to those presented at an earlier Cornwallis by Andrew Hossack of the UK. In fact, Mr. Hossack’s and our own research and work were developed independently. We became aware of Mr. Hossack’s work later due to Cornwallis and Gene Visco. The fact that many of our conclusions are similar to his, simply serves to demonstrate what can be done with a little solid historical research and analysis developed from that. In the UK, they actually now label what we do as a separate discipline of Operations Research, called Historical Analysis.

The scope of this work is beyond the reach of any single individual. In our case, it was conducted by a team of a dozen researchers, historians, analysts and statisticians over the course of more than a year. We wish to thank all of our various sponsors for giving us a chance to develop the work to this extent.

\[
\log\left(\frac{\pi_i}{1-\pi_i}\right) = -1.34 + 0.29(\text{Force Ratios}) + 1.47(\text{Limited}) - 1.76(\text{Central})
\]

s.errors: \(0.16 \quad 0.11 \quad 0.14 \quad 0.10\)
p-values: \(0.1996 \quad 0.0068 \quad 0.0935 \quad 0.0799\)

Similar work was done for the other factors we examined, including the effects of terrain, rules of engagement, levels of brutality and many others. Our work produced 10 analytical reports that totaled over a thousand pages, based upon analysis of 83 insurgenacies, interventions and peacekeeping operations.
Twelve years ago, in 1997, the controversy over Iraqi weapons of mass destruction led to the release of additional data on Iraqi use of chemical weapons in the Iran-Iraq War (1980-1988). This, as well as new data released by the Iranian government, has shed better light on aspects of chemical casualties experienced by Iranian forces during that conflict which were discussed in a previous article on overall Iranian casualties in the Iran-Iraq War and causal proportions of those casualties. Significant data was compiled and released by the United Nations Special Commission (UNSCOM) pursuant to UN Resolution 687 in a report dated 6 October 1997.¹ Other sources were a US Government White Paper released 13 February 1998 and a “Q&A” sheet issued by the United States Information Agency on 19 February 1998.² Additional data came directly from the Iranian Foundation for the Disabled and Oppressed and other Iranian sources. The original version of this ar-

article was written in 1998 and not published. It has now been revised and updated to include data and information released in the last twelve years.

The UNSCOM report traced the inventory of Iraqi chemical agents and munitions before, during, and after both the Iran-Iraq and Desert Storm Wars. It was based on Iraqi-provided data, much of which may be inaccurate, or deliberately false or misleading, but it provides the only quantified data base regarding these weapons as a point of departure. Among the data are interesting statistics about the amount of agent and number of munitions expended against Iranian forces. According to Iraqi figures, some 2,870 tons of chemical warfare agents were consumed from 1981 to 1988. Further, this tonnage was employed in 101,080 munitions expended. Throughout the war, Iraq employed chemical weapons against Iranian forces at least 195 times although as many as 300 and even 400 attacks have been claimed. In 2002, Iran insisted some 6,000 tons were actually employed. Later Iranian claims in 2008 refer to 2.5 million kilograms of chemical agents, or 2,500 tons which is more in line with Iraqi statements. It seems that mustard agents—particularly the infamous and effective Iraqi "dusty" mustard—caused the majority of chemical casualties in the war judging by post-war Iranian medical literature, where populations of gassed soldiers studied are as high as 1,500. Some 3,000 men were exposed to mustard gas from Fars Province alone. The Iranian Revolutionary Guard Corps or Pasdaran maintains its own medical school, the Baqiatollah Medical University. Enrollment was 2,000 in 1998. One of its tasks is to compile and maintain a data base on Iranian chemical wounded from the War of Sacred Defense.

The types of munitions employed were not enumerated. However, corollary data indicates that, prior to the Desert Storm War, Iraq had the following inventory of munitions dedicated to chemical agent delivery:

- Rockets ~ 100,000
- Artillery Shells ~ 30,000
- Aerial Bombs ~ 10,000

At first, it seemed likely the Iraqi inventory in the Iran-Iraq War was similar. If so, rockets accounted for 72%, artillery shells for 21%, and bombs 7% of the total inventory of chemical munitions. However, the munitions expended divided into the amount of agent consumed (2,870,000 kg/101,080) indicated "average" munitions must have had a 28 kg fill. This corresponds exactly to a KhAB-100 class aerial bomb (100 kg with 28 kg fill of mustard). This suggests the majority of agent was delivered by aerial bombing. The usual Iraqi aerial chemical strike was five MiG-23 or MiG-27 aircraft each carrying 4-6 250 kg chemical bombs (KhAB-250) with a 49 kg chemical fill. Such a strike could deliver 980 to 1,470 kg of agent. However, oftentimes up to 50% of these bombs failed to detonate. Iraq also used flights of 2-3 helicopters to drop 220 liter containers which detonated on ground contact.

Artillery shells, mortars and small caliber rockets deliver only 5-8 kg of chemical agent on the average. Artillery shells are the least efficient, with 5% of their weight as agent fill. Mortars are better at 10%. Tactical rockets can deliver about 15% of their weight as agent. Best of all are large rocket or missile warheads which contain 30-50% of their overall weight as agent fill. The R-72 Luna-M (FROG-7) 960 kg warhead has 475 kg of agent was delivered by aerial bombing. The usual Iraqi aerial chemical strike was five MiG-23 or MiG-27 aircraft each carrying 4-6 250 kg chemical bombs (KhAB-250) with a 49 kg chemical fill. Such a strike could deliver 980 to 1,470 kg of agent. However, oftentimes up to 50% of these bombs failed to detonate. Iraq also used flights of 2-3 helicopters to drop 220 liter containers which detonated on ground contact.

3 UNSCOM, 11.
4 UNSCOM, 12
5 “Curing the Victims of Chemical Weapons: From Rumor to Reality,” Iran Daily (9 May 2002); “Iraq Chemically Attacked Iran 196 Times,” Etemaad Daily (3 February 2003); “2,000 Iranian Chemical Victims Sue German Companies,” Sharg Daily (4 July 2004).
6 “Iran Insists Iraq Had Used 6,000 Tons of Chemical Weapons,” IRNA (25 December 2002).
10 “Baseej to Hold Maneuvers, 500,000 to Participate,” IRNA (18 November 1998)
11 White Paper, Appendix B
13 “CW Use in Iran-Iraq War,” 062596_cia_66846_01.txt
A mortar round could contaminate 50 cubic meters; an 82mm round 200, and a 120mm round 1,000.\textsuperscript{15}

If we fill all the pre-Desert Storm munitions (5 kg per artillery shell, 8 kg per rocket and 49 kg per bomb) the total munitions fill is 1,440 tons. This is exactly half of the claimed Iraqi agent consumption. This taken alone suggests that the Iraqis fired twice the amount of chemical munitions (280,000) against Iran, than they had on hand to combat coalition forces. However, the number of munitions expended is only listed as 101,080 - only 36% of the theoretical total. This again suggests that the munitions proportion in the Iran-Iraq War was different, with many more large capacity aerial bombs.

The 195 known Iraqi chemical attacks must have averaged about 518 munitions per attack (101,808/195). This is roughly what two 6-launcher batteries of BM-21 class multiple-rocket launchers could accomplish in under 30 seconds. Conversely, it would take three artillery battalions of 18 guns firing four rounds sustained about 2.5 minutes. However, each attack would also average 14,504 kg of delivered agent (2,870,00/195). This would then require either 296 KhAB-250 class bombs, 1,813 122mm class rockets, or 2,900 152/155mm artillery shells. Also complicating any definitive calculation is that the 195 known “attacks” may be a seriously incomplete count or a highly-aggregated figure useful only in the most general sense. Iranian figures claim 242 attacks by March 1988.\textsuperscript{16}

The problem may be simplified in that, despite its later inventory before the Desert Storm War, Iraq does not seem to have used rockets to deliver gas in the Iran-Iraq War. A quick review of Cordesman’s accounts of chemical incidents and delivery means indicates air delivery by fighter or helicopter was the most common method. Artillery and mortars participated in delivery 58%; aircraft or helicopters 79%; and both 42% of the time. Only in 16% of incidents did artillery act alone, but in 32% aircraft acted alone.\textsuperscript{17} There is no definite mention or suggestion of rockets except for the allegation that air-to-ground rockets with chemical submunition warheads were used in 1984.\textsuperscript{18} This is a novel delivery means of high sophistication unknown in the arsenals of any other nation. It is probably the misidentification of an incendiary or smoke weapon.

It is reported that Iraqi Luna-M (NATO: FROG-7) heavy battlefield rockets were fired with chemical warheads filled with HD (distilled mustard) against Iranian rear areas during the Iran-Iraq War.\textsuperscript{19} These could not have been many as only about seventy Luna are known to have been fired in the whole war, and none after 1984. Iran reported no mustard gas casualties until 1982. On 27 October 1982, near Musain, four Iranian soldiers died from toxic chemical exposure, probably mustard gas. There were only 29 total gas casualties reported for that year. In mid-August 1983, Iran suffered 318 casualties from mustard and arsenic agents. On November 7, 9, and 13 1983, Iraq used mustard in the Panjwin area. Four seriously wounded Iranian soldiers later died in European hospitals.\textsuperscript{20} The final total gassed in 1983 was 564.\textsuperscript{21} Only about five Luna were fired in these two years, all at Dezful. Additionally, Iraq declared to UNSCOM that it had only experimented with a chemical warhead for the Luna series in 1988 without success.\textsuperscript{22}

Given this simplification we can algebraically calculate the number of 152/155mm artillery shell and 250 kg bomb equivalents used to deliver the 101,080 expended munitions and 2,870,000 kg of agent.

Let $x$ = number of artillery rounds
Let $y$ = number of bombs
Let 5 kg = average fill for artillery shell
Let 50 kg = average fill for bomb

Our system of linear equations in two unknowns is:

\begin{align*}
(1) \quad x + y & = 101,080 \\
(2) \quad 5x + 50y & = 2,870,000
\end{align*}

Collecting terms and canceling in equation 2 results

\textbf{Iraq War, “SIPRI Fact Sheet (May 1984).}
\textbf{20 Cordesman, 188n23, 513-518.}
\textbf{21 James Smith, “Chemical Weapons Proliferation,” Jane’s Soviet Intelligence Review (May 1991), 194-198.}
\[ x + y = 101,080 \\
\]
\[ x + 10y = 574,000 \]

Subtracting equation 1 from equation 2 leaves:

\[ x + y = 101,080 \]
\[ 9y = 472,920 \]

Again collecting terms and canceling in equation 2 we arrive at:

\[ x + y = 101,080 \]
\[ y = 52,545 \]

Subtracting equation 2 from equation 1 results in:

\[ x = 48,535 \]
\[ y = 52,545 \]

From this we can conclude that 48% of the munitions were artillery and mortar shells, and 52% were aerial bombs. Given an average chemical bomb load of five 250 kg equivalents the Iraqi air force carried out something like 10,500 \((52,545/5)\) chemical sorties, or roughly 5% of its total sorties against Iranian ground forces. The air force also delivered 92% of all agent, with 8% delivered by Iraqi ground forces artillery. In World War I chemical artillery rounds made up 5% of all artillery shells fired and 90% of all chemical agents delivered.\textsuperscript{23} We see the exact opposite in the Iran-Iraq War where air force delivery of agent exceeded artillery by a factor of twelve.

The number of munitions claimed expended by Iraq is paltry contrasted to WWI standards. At Riga on 1 September 1917, the Germans fired 116,400 chemical shells at a rate of 388 a minute into Russian forces causing 1,000 casualties. In the first German spring of-

fensive of March 1918 German forces fired two million gas shells inflicting 14,860 casualties. 24 7,000 of these were suffered by the BEF 2nd and 63rd Divisions, which were on the receiving end of 120,000 gas shells over a three-day period. 25 The amount of agent expended in this eight-year conflict is also small contrasted to the Great War. At least 100,000 tons of chemical agent were expended in WWI. 26 The British Special Brigade alone discharged some 5,700 tons in just less than three years from September 1915 to August 1918 in some 378 distinct gas attacks. 27 Iraqi usage is only 2-3% that of WWI. In WWII, the US had 32,000 tons of agent earmarked for the invasion of Japan. 28 This is over eleven times Iraqi expenditure. The number of attacks—242 according to Iranian data—is also minuscule contrasted to World War I. Given that the average WWI gas attack against a specific target involved about 300 shells, something like 22,000 “attacks” occurred in the War to End All Wars.

After the publication of my original article I discovered an interesting and detailed listing of Iranian chemical casualties. Iran first claimed Iraqi use of chemicals in an air attack on Susangerd in November 1980. By 16 February 1984, Iran alleged 49 instances of Iraqi chemical weapons employment in which 109 were killed and “hundreds” wounded. 29 Iran claimed the following chemical casualties year by year during the war in 242 overall Iraqi gas attacks. 30

- 1981: 11
- 1982: 29
- 1983: 564
- 1984: 2,237
- 1985: 3,267
- 1986: 11,141
- 1987: 13,496
- 1988 (Jan-Mar): 13,300
Total: 44,050

This listing is at odds with other Iranian statements that in all they had suffered 25,600 gas casualties by April 1988, of which 260 (sic 2,600 ?) died. 31 It is some 72% larger.

New data on Iranian chemical casualties was released in 1998 by the Iranian government in conjunction with the tenth anniversary of the Hajabla incident, much covered by the world press. 32 In March 1998, Farzad Panahi, Deputy Director of the Foundation for the Disabled for health and medical treatment, said that 60,000 Iranian soldiers had been wounded by chemical weapons during the imposed war with Iraq. According to his data, 50-60% suffer from pulmonary diseases, 30% have ocular disorders and the rest have skin diseases. 33 The main treatment center for chemically

26 Donovan Webster, *Aftermath: The Remnants of War* (New York: Vintage Books, 1996), 24-25. WWI shells, many still cast iron, had poor capacity for agent fill. 4” Stokes mortars were very efficient with about a 4 kg fill, while the Livens projector delivered almost 14 kg of agent. Howitzer artillery shell might carry as little as 1.5 kg, but usually not more than 3 kg from weapons as large as 150mm. A modern 152/155mm howitzer has about a 5 kg fill.
31 Cordesman, 516-517.
33 “60,000 Chemically Wounded Iranians Under Treatment,” *IRNA* (12
wounded persons is the Isar Center in Sari, Mazandaran Province. In 2006, a new nationwide plan was implemented to assess war veterans’ suffering from chemical exposure. Mostafa Qanei, Director of the Center Dealing with Chemical Victims, said that of 40,000 chemical victims in Iran, 100 were in very critical condition. Overall 15% of war veterans with chemical wounds are in serious condition. Iranian research indicates it takes 15-20 years for a chemical injury related disorder to advance from a mild to a moderate or serious stage.

This data now indicates that chemical weapons accounted for about 6% of Iranian battle casualties, rather than the 4% proposed in my earlier article when Iran admitted only 30,000 chemical injured. It also indicates that the Iranian chemical casualties in the last five months of the war amounted to about 16,000, if we accept the 44,000 figure by March 1988. This seems more reasonable than 25,600 (misprint for 45,600?), which would require another 34,400 casualties in the same five months to reach the total of 60,000. The pattern though is the same: Iranian chemical casualties doubled in the last year of the war.

In August 1998 Mohammed Baqer Nik-Khah, deputy head of the Foundation for Preservation of the Documents and Values of the Sacred Defense and himself a chemical warfare victim, stated that the death toll from Iraqi chemical agents “surpassed 10,000,” and these weapons injured 50,000. In November 2000, Abbas Kani, head of the Legal Office for War Veterans, stated that some 15,000 had died since the end of the war due to chemical injuries. This also indicates that the Iranians over time counted post-war dead as war dead and subtracted from their “injured” totals as required. The figures (2001) seem to suggest: 65,000 total casualties of which 5,000 are battlefield dead, 15,000 post war died of wounds and 45,000 still living wounded. Some 45,000 civilians were also affected by chemical weapons. Many of these were women. A seminar entitled “The Patient Defenders” was held on 30 September 1999 in Tehran to examine the impact of chemical weapons specifically on women disabled by toxic agents during the imposed war with Iraq.

On the tenth anniversary of the Halabja incident the US Department of State claimed 20,000 Iranian soldiers had been killed by Iraqi chemical agents. This figure may be correct but 75% of them are post-war deaths. If this is true, it indicates a 25% latent death rate for the 60,000 estimated chemical wounded.

As such, this new data causes a modification in the chemical casualty graph presented in my original article. The graph now should read:

Chemically wounded in the war continue to die. In December 1998, Brigadier General Mohammed Farivar Khomani died. As a division commander, he was gassed in 1986 during the Beit ol Moqaddas offensive near Fakkeh. He had been under constant medical care since that time. In spring 2000, more chemical wounded were reported dying. Amir Hossein Pourguneh of Shirvan, Khorrassan Province, succumbed to wounds received in 1987 on 31 May 2000. On 7 June 2000, Brig. Gen. Abdul Reza Muzeh died of chemical injuries resulting in prolonged systemic infection. On 10 June 2000, Abbas Hassani likewise passed away as a direct result of chemical injuries sustained during the war.

35 “40,000 Victims of Chemical Weapons in Iran,” IranMania (21 May 2007).
36 “Litigations to Accentuate Sufferings of Iranian Nation During War,” IRNA (8 August 1998).
37 “Over 15,000 War Veterans Died of Chemical Weapons Syndrome,” IRNA (13 November 2000).
38 “Official Says Germany, US and Britain were Main Suppliers of Chemicals to Iraq,” IRNA (1 December 1996).
39 “’Patient Defenders’ Seminar to Study the Impact of Chemical Warfare,” Iran News (28 September 1999).
being gassed in the war. All deaths were reported to the UN offices in Tehran by the Society Supporting War Veterans Wounded by Chemical Weapons, according to executive secretary Mohammed Hassan Maleki. Another Baseej chemically-wounded, Yousef Khoshshi, died in Karaj on 2 July 2000. Two days later two more veterans—Gholamreza Madani of Tehran and Khodadad Najafi of Fars province—both succumbed to their wartime chemical injuries. At the end of the month yet another chemically-injured—Golamhossein Rezaie of Isfahan—died. Two more—Amir Hossein Kambuzia and Hassan Qadamqahi—passed away in early August 2000. In late August, Fazollah Geryan died of his chemical injuries. In mid-September, yet another two chemically-wounded from 1985 and 1987—Faraj Yahya-Ee and Haj Saeed Pour Safari—died. This brought the total to more than 20 over the year. Two more— Kamran Jheddi Nejad and Mohammed Etemadi—died in early October 2000. In November 2000, Avbbas Kani, head of the Legal Office for War Veterans, stated that some 15,000 have died since the end of the war due to chemical injuries.

In all of the year 2000, some 20 chemical casualties died, making about 1,400 since 1981. Some 2,000 others were in critical condition. In July 2001, Col. Ali Hussein Abadi died of his injuries. By then over 300 wounded had died since the war’s end. These last two numbers are, of course, far fewer than the 15,000 post-war deaths reported elsewhere. They must refer to deaths in a particular city or perhaps major hospital complex, the detail of which was lost in the editing of the particular obituaries. In August, Alireza Nazari, gassed at Halabja in 1988, died. Brig. Gen. Taqi Rae Dehnaki, chemically wounded in 1987, died in September. Ayoub Bolandi died in October, chemically wounded over 75% of his body in March 1981. Hossein Safei, General Manager of the War-Disabled Veterans Affairs Office in Khorassan Province, said that 40 war veterans were in critical condition and that 4,000 others in Khorassan were not responding to treatment. Some 67 war veterans from Khorassan injured by chemical weapons had died. Another side effect was infertility among gassed soldiers. Out of 81 mustard gas patents, 34 had no sperm and 47 had reduced sperm counts. Some 44 were categorized as severely injured, 20 moderately injured, and 17 mildly injured. Typical of survivors is Rezai Mohammed. In 2002, he was a permanent patient at Tehran’s Sasan Hospital on oxygen due to severe respiratory problems from mustard gas exposure in 1985. He also suffered from chronic skin boils. Akbar Salimi, another patent, had undergone three operations to stop intestinal bleeding from mustard gas exposure in 1987.

In 2002, IRGC Col. Mohammed Akbari was still suffering from his mustard gas exposure in 1985, and his son, born in 1993, has been diagnosed with a nervous disorder related to the exposure. At Baqiatallah Hospital in Tehran in 2002, Jalal Taqvi, gassed at Abadan in 1987, suffered from numbness of his right side and was partially paralyzed. In the same year, at the Sasan Hospital (also in Tehran), the beds reserved to treat chemical warfare victims were often 60% filled, ac-

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43 “Chemical War Veteran Martyred in Karaj,” Tehran Times (3 July 2000).
44 “Two Iranian War Veterans Martyred in Karaj,” Tehran Times (3 July 2000).
45 “Two More War Veterans Injured By Iraqi Chemical Attack Martyred,” IRNA (6 August 2000).
46 “Another War Veteran Injured By Iraqi Chemical Warfare Martyred,” IRNA (4 September 2000).
47 “UN Chief Urged To Heed Chemical Warfare Victims,” IRNA (16 September 2000); “Another Iranian Victim of Iraq’s Chemical War Succumbs to His Injuries,” IRNA (17 September 2000).
49 “Over 15,000 War Veterans Died of Chemical Weapons Syndrome,” IRNA (13 November 2000).
60 Brian Murphy, “Iranian War Victims Still Suffering,” AP (15 October 2002).
cording to chief physician Hamid Jamali. In January 2002, Davoud Tarkhani, father of six, died of chemical wounds received at Fao in 1985. Raim Moradi died in February after suffering 70% disability from chemical injuries. Azizullah Zamir died in April from chemical wounds sustained in Fao in 1986. Alizeza Bayat, injured in the 1985 Badr operation, died in June. During this eight-day operation Iraq dropped 77 chemical bombs and fired 23 chemical rockets and 639 chemical shells into advancing Iranian formations. This resulted in 32 Iranian chemical deaths and 2,231 chemically wounded. The same month, Kazem Kiyan Pisheh also passed away from his wounds sustained during the Wal Fajir 8 operation. And, ten days later, Mohammed Reza Hashemi, injured in the Beit ol Moqaddas operation in 1988 and 70% disabled, succumbed. In the first week of July six veterans died, including Brig. Gen. Mohammad Ali Ameri Mazaher Aghajanlou who was wounded in the 1987 Nasr operation; Gholam Reza Javad Pour Samak, who was also an ex-PoW. Others were Ali Asghar Hashemi, Seifallah Gholami, and Amrallah Naderan. Later, in July, Mohammed Ali Boulaki, wounded in the chemical bombardment of Majnoon Island in 1988, died.

In 2002, statistics indicated 100,000 military personnel and civilians had been exposed to chemical agents during the war. Of these 40,000 were affected enough to require treatment. About 90,000 were military, of which 70,000 were referred to healthcare programs. About 35,000-40,000 qualify as chemical casualties. Of 6,000 civilians, 3,500 are under medical care. One group of 4,300 was referred to the Chemical Patients Committee of the Janbazan Foundation. Of these, 586 had 70% or greater disability, and 3,264 had 50% or less disability. By January 2003, 5,000 to 6,000 chemically wounded were still under treatment, and 1,000 of these were moderately to critically ill. Esmail Khoshnevisan, gassed ferrying wounded soldiers in southwestern Khuzistan, had chronic breathing problems and had lost all his teeth due to degeneration of his gums. Mohammed Reza Bajelan inhaled mustard gas when his gas mask valve jammed in 1985 and coughed up blood chronically. Mohammed Reza Abbasi was a fifteen year old Baseej clearing minefields when he was mustarded. All three were patients at the Sassan Hospital in Tehran in 2003. In February 2003, Mohammad Hossein Hosseinehadi died from chemical wounds. Mohammed Reza Yazdani Vafa was gassed five times during the war beginning in the Majnoon offensive of 1982. He survived the Iraqi attack on Halabja in 1988. His main injury was loss of sight in his left eye and diminished vision in the other, as well as swelling and blistering on his skin. He received 1.5 million rials (about $180) a month for his pension. In June 2004, Dr Mostapha Qanei published A Guide to the Health of Chemically Injured War Veterans intended for patients suffering from chemical exposure. The book was free from the Research Office of the Chemically Wounded Veterans Committee. It prescribes health tips to avoid aggravating the condition of the wounded. In September 2004, Davood Karimi died in Sasan Hospital of chemical wounds. By 2004, Iranian figures claimed 120,000 veterans chemically injured. Of these 45,000 including 7,000 civilians were monitored by the Janbazan Foundation. Some 11,348 suffered from skin lesions, 15,562 from ocular injuries, and 17,750 from pulmonary damage. At least 126 had died in the previous 20 years from cancers caused by exposure to HN or sulphuric mustard gas.

In March 2005, Brig. Gen. Mohammed Noureddin

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61 Farnaz Fassihi, “In Iran, Grim Reminders of Saddam’s Arsenal,” New Jersey Star-Ledger (9 December 2002).
62 “Another Chemically Disabled War Veteran Succumbs to His Injuries,” IRNA (12 January 2002).
63 “War Veteran Succumbs to Injuries,” IRNA (3 February 2002).
64 “Chemically Injured War Veteran Attains Martyrdom,” Tehran Times (10 April 2002).
67 “Another Chemically Disabled Veteran Dies,” IRNA (9 July 2002).
69 “Curing the Victims of Chemical Weapons; From Rumor to Reality,” Iran Daily (9 May 2002).
73 “40,000 Chemically Wounded Veterans in Iran: Professor,” Tehran Times (28 June 2004).
74 “Chemically-Wounded War Veteran Succumbs to His Injuries,” Tehran Times (7 September 2004).
75 “2,000 Iranian Chemical Victims Sue German Companies,” Sharq Daily (4 July 2004).

In 2008 the following chemical wounded statistics for 2006 were released:

<table>
<thead>
<tr>
<th>Severity</th>
<th>Lung</th>
<th>Eye</th>
<th>Skin</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>14,580</td>
<td>12,900</td>
<td>25,670</td>
<td>37,300</td>
</tr>
<tr>
<td>Moderate</td>
<td>3,530</td>
<td>2,224</td>
<td>1,510</td>
<td>7,264</td>
</tr>
<tr>
<td>Severe</td>
<td>640</td>
<td>438</td>
<td>18</td>
<td>1,096</td>
</tr>
</tbody>
</table>

Other interesting graphs were also presented.

This graph indicates most chemical munitions were delivered by aerial bomb. This is consistent with Iraqi statements after Desert Storm about expenditures of their chemical stockpiles in the War of Sacred Defense. This is consistent with the algebraic evaluation originally done in 1998 for this article.

Another graph of interest displays proportions of chemical casualties by season of year.

The graph indicates about 27,000 total casualties and obviously does not reflect total gas casualties, but some representative population of a particular war year—most likely 1987-88. Some two-thirds, or 66%, of all casualties were suffered in winter. This might be expected, as cooler winter temperatures made chemical agents less volatile and more persistent, leading to longer casualty-producing periods of contamination. Summer saw about 18% of casualties and spring 11%. Autumn, interestingly, only indicates about 1-2% of all casualties, showing use of chemical weapons was unfavorable or highly ineffective in this season.

For 65,000 estimated Iranian military chemical casualties (includes 5,000 estimated maximum killed), the amount of ordnance delivered was very efficient. It inflicted roughly one military casualty per 1.56 munitions expended (65,000/101,080 = 0.64). This is much better than WWI, in which 66 million chemical artillery rounds inflicted 965,140 casualties, or one casualty per 68 shells. The Iranian ground forces were generally ill-prepared for chemical defense. During the course of the War of Sacred Defense, much NBC defense gear was purchased from the UK, Germany and Czechoslovakia, but there was never enough and NBC defense training was insufficient. Many Iranian soldiers became gas casualties because they did not shave often enough to allow their protective masks to make a tight seal.

In 1984, Iran bought gas masks from the Republic of Korea and East Germany. The RoK masks were too small for Iranian faces, and the filters were only good for fifteen minutes. The 5,000 East German masks ended up being used as goggles for spray-painting crews. Not until February 1988 did Iran produce its own two-piece chemical protective suit, the Derkash-6. Only in

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76 “Another Iranian War Veteran Dies,” IranMania (15 March 2005).
77 “Memorial Service Held for War Veteran Suffering from Chemical Attack,” IRNA (6 November 2006).
78 “Another Chemical Attack Victim Succumbs to Injuries,” IRNA (5 August 2007).
79 “War Veteran Abdollah-Pour Succumbs to Chemical Wounds,” IRNA (6 October 2007).
80 “Another Iranian Chemically Injured Patient Was Martyred,” IRNA (21 July 2008).
81 “Iranian Chemical Victims According to the Type of Chemical Agent and Extent of Injury,” chemical-victims.com/DesktopModules/Articles/Articles/ArticlesViewPrintable.aspx”?TabID
82 Hogg, 136. The residual 25% of WWI gas casualties were victims of cloud attacks.
83 Cordesman, 2: 516.
April 1988 did they begin domestic production of gas masks.\textsuperscript{84} Despite these improvements one out of every ten severely gassed Iranian soldiers died before receiving any treatment.\textsuperscript{85} Only a third of Iranian troops had anything like even partial NBC defensive kit. Many units went into combat without even protective masks. Most pictures show usual Iranian NBC defensive gear as no more than a mask, and occasionally a pair of rubber gloves. In July 1998 it was confirmed that on 17 and 18 April 1988 Iraq introduced VX nerve gas delivered by artillery shell and aircraft bombs during the Fao Peninsula offensive. This new agent inspired panic among \emph{Pasdaran} formations.\textsuperscript{86} Without even the protection of a WWI class army, it is a miracle that chemical weapons inflicted only 6\% of overall Iranian casualties. At the munitions to casualty ratio of the Iran-Iraq War, WWI’s 66 million gas shells would have caused 42 million military casualties!

From the same Iraqi data we learn 44 kg of delivered agent was necessary to inflict a military casualty. WWI data, depending on circumstance of use and agent, indicates anywhere from 50-250 kg were required to produce a casualty, although it must be borne in mind that only cloud or projector attacks used this measure of merit.\textsuperscript{87} Using our 5 kg standard for artillery, WWI’s 66 million shells amounted to 350 kg per casualty. Again at the Iran-Iraq War ratio, they would have inflicted 7.5 million casualties!

If we consider the civilian chemical casualties together with military (roughly 100,000), then Iraqi chemical munitions had a one-for-one (0.99) casualty ratio; agent amount per casualty is 28.7 kg.

The only other more specific data we have consists of a couple of points. On 17 March 1984, four Iraqi aircraft each carrying eight 100 kg chemical bombs loaded with about 28 kg of Tabun nerve agent attacked an Iranian position. About 400 troops “were affected.”\textsuperscript{88} This translates to 12.5 casualties per munition and one casualty per 2.24 kg of agent delivered. However, only 40 casualties were observed hospitalized. In the Wal Fajir 8 fighting in February 1986, Iraqi forces reportedly fired 7,000 chemical artillery and mortar rounds on Iranian positions and dropped 1,000 chemical bombs over the operational theater.\textsuperscript{89} This resulted in approximately 8,500 Iranian casualties. This translates to a rate of 1.06 casualty per munition. Using our agent fill standards, it represents one casualty per 10 kg of agent employed.

Other strange chemical episodes were also reported. In March 1984 near Guziel, groups of Iranian corpses were found bearing no external trace of injury. The victims appeared to be asleep.\textsuperscript{90} This was assumed to be some novel chemical agent. The report bears a strong similarity to contemporary reports from Afghanistan. Nicknamed “The Flash,” this agent was purportedly used on one occasion in Afghanistan, inducing instantaneous death with no chemical poisoning symptoms. Afghan Mujahadeen fighters were reportedly found stone dead in their foxholes still aiming their weapons.\textsuperscript{91} Although not a chemical agent, Iran also claimed use of “microbic” and “bacteriological” weapons by 1984. Israeli reports claimed anthrax had been diagnosed in some hospitalized Iranian troops.\textsuperscript{92} This was neither specifically claimed by Iran nor proved by UN inspectors.

This data would suggest munitions-to-casualty ratio has decreased over 44 (68/1.56) times since WWI, and agent-amount-to-casualty ratio has decreased by a factor of at least eight. On average, chemical weapons should have been about five times “better” in the Iran-Iraq War in their casualty-causing potential than in WWI. Yet, overall casualty patterns and proportions compared are almost exactly the same in both conflicts! This suggests that chemical weapons have become more \emph{efficient}, but overall battlefield \emph{effectiveness} (in terms of inflicting a greater proportion of casualties) has not changed since the Great War.

The only other body of historical-empirical chemical lethality data comes from chemical agent use by the Imperial Japanese Army in the China War (1937-1945). During this conflict, Japanese forces employed

\textsuperscript{84} Jean Pascal Zanders, “Iranian Use of Chemical Weapons: A Critical Analysis of Past Allegations,” SIPRI Chemical and Biological Warfare Project (7 March 2001).
\textsuperscript{85} Saddam’s Chemical Victims Still Suffering in Iran,” Reuters (20 January 2003).
\textsuperscript{86} “Iraq Reportedly Used VX Gas in Iran-Iraq War,” Reuters (3 July 1998).
\textsuperscript{87} Hogg.
\textsuperscript{88} Robinson and Goldblat.
\textsuperscript{89} “Violation of International Rules by Iraq,” Sacred Defense Epic, \emph{IRNA} (23 September 1998).
\textsuperscript{90} Robinson and Goldblat.
\textsuperscript{91} David C. Isby, \emph{Weapons and Tactics of the Soviet Army} (2d ed.; London: Jane’s, 1988), 301.
\textsuperscript{92} Robinson and Goldblat.
chemical weapons at least 1,688 times and perhaps over 2,000 times. Mustard and Lewisite were used at least 1,000 times. Other agents included Phosgene, Blue Cross (Diphenylchloroarsine), Hydrocyanic Acid, and Chloroacetonphenone. The Chinese have two sets of conflicting casualty data. For 1,688 attacks, one claim is 6,000 killed and 41,000 wounded. This translates to a 13% lethality rate and a wounded-to-killed ratio of 6.8:1. Casualties per attack are only 28. A second set of figures claims 200,000 total casualties in 2,000 attacks with 40,000 fatalities. This is a 20% lethality with a wounded-to-killed ratio of 5:1. Casualties per attack are 100. A third set claims 80,000 total casualties with 10,000 deaths, but no attack count. This gives 13% lethality with a 7:1 wounded-to-killed ratio. The first set is probably the more correct as it was compiled by the Engineering Academy of the Chinese Army Chemical Defense Command. Some 2,000,000 rounds filled with chemical agents abandoned by Japanese forces are scattered throughout China, and some 2,000 people have become casualties since the war due to these ex-Japanese gas caches. Even the larger set of figures, if true, represents only a trivial fraction of the Chinese deaths and injuries in the China War (3,311,419 military casualties; perhaps 35,000,000 total civilian and military casualties, with 15,000,000 civilians dead -- nobody really knows). The Nanking Massacre of 1937 alone took 260,000-355,000 lives in just six weeks by bullet, bayonet, sword and assorted other cruel devices, but no gas.

If we accept that 50% of the chemical bombs failed to detonate and ignore them and their agent fill, we get even more outrageous ratio figures per military casualty (1.2 per munition and 24 kg of agent required). It would also mean that there were something like 25,000 unexploded chemical bombs in southeastern Iraq and southwestern Iran at war’s end. Yet Iranian combat engineers had only discovered and neutralized 100 unexploded Iraqi chemical munitions of all types as of 1991. As of 1996, 5,207,600 pieces of unexploded ordnance (not including mines) had been neutralized. By way of contrast, the French Département du Dém intelligence neutralizes about 900 tons of unexploded ordnance a year (80% of it from WWI). Of this number, 30 tons are chemical rounds (3% overall, 4% of WWI munitions). The latter figure matches almost exactly the percentage of chemical rounds fired in the Great War (5%).

A final note: In the 1997 crisis we again saw exaggerated, almost hysterical, accounts of Iraqi chemical weapons’ lethality in the Iran-Iraq War. A paper published by the American Enterprise Institute in February 1998 claimed “Postwar analysis showed that they [chemical agents] were far more effective than conventional weapons and warfare.” I do not believe a careful analysis of the facts supports this assertion. As far as I know there is no body of “postwar analysis” data readily available outside of what this article and its predecessor have cited.

USIA’s “Q&A” paper says that “16,000 Iranians were reported killed by toxic blister agent mustard gas between August 1983 and February 1986.” Once again, a government agency cannot distinguish between killed and overall casualties. Iran’s military chemical deaths were probably no more than 5,000 (at most 10,000) in the entire war and in the time period cited amounted to 1,200-2,500 (1,800 is a good guess). From Iran’s own figures, we know there were a total of 6,108 chemical casualties by the end of 1985. At the end of 1986 there were 17,249. A bad year to be sure, but the wounded far outnumbered the dead.

Gas hysteria in the press is nothing new. In the first German gas attack on 22 April 1915 against the French 45th and 87th divisions, results were disappointing. The Germans estimated it had only caused about 200

94 Kyodo (1 August 1992).
95 Xinhua (18 September 1995).
97 Harris, 67, 235-238; Deng and Evans.
100 “IIR 2 762 0059 92 Iranian Analysis of Iraqi Chemical Ordnance Used During Iran/Iraq War.”
102 Webster, 24-25.
104 USIA, 1.
French casualties. The French army calculated the casualties at 625. However, the French press reported 5,000 killed!  

Further, as regards the lethality of mustard gas in particular, deaths per wounded soldier in WWI were about 2%. If 16,000 were indeed killed by mustard, then this would suggest Iran’s chemical wounded from mustard alone were on the order of 800,000 or eight times the highest total Iranian acknowledged chemical casualties! However, if you are going to die from any chemical agent, mustard is a good bet. Of 1,221 hospital deaths from chemical agents experienced by the AEF in WWI, 600 (50%) were due to mustard. By contrast, the arsenic-based German “Blue Cross” (diphenyl chloroarsine) produced only 3 deaths in the AEF out of 580 total casualties from this agent (0.5% lethality)!

There are other reports of as many as 5,000 Iranian chemical deaths from mustard gas, and the vast majority of post war chemical injured are mustard casualties. According to the CIA, Iraqi forces used an unidentified silica compound impregnated by mustard gas against Iranian forces. This substance was delivered in White Phosphorus shells. The silica compound reduced the amount of mustard gas the shell could carry, but actually decreased the dose rate required to produce a casualty, resulting in effectiveness five times the standard shell. It apparently helped the agent create a vapor rather than a contact hazard among those exposed. It was noted that Iranian soldiers exposed to mustard gas had unusually high amounts of respiratory injuries as opposed to the more common skin blistering. The higher proportion of lung injuries among Iranian soldiers would increase the agent’s overall lethality.

According to some reports, not all Iranian chemical deaths were battle-related. One story tells of ten Iranian PoWs taken to the Saudi border, tied to posts and then exposed to anthrax from a bomb detonated fifteen yards away. Other anthrax tests were conducted on Iranian PoWs at an underground facility at Salman Pak. In June 1994, UN inspectors found a mass grave near Salman Pak which was suspected of containing victims of Iraqi bio-chemical weapons’ research. In July 1998, Iran claimed it had information that some 1,000 Iranian and Kuwaiti PoWs had been subjects of Iraqi chemical agent tests. Another 170 Iranian PoWs have reportedly been summarily executed or died under torture in recent years.

The historical record suggests gas is a case of threat versus anxiety, provoking a “gut” rather than a “logical” reaction to its use as a weapon. Yet threat often must be evaluated on an individual basis, as well as statistical. It’s one thing to dispassionately calculate these numbers thousands of miles distant from and years later than the chemical battlefields of World War I or the Iran-Iraq War. It is quite another to be one of 400 surviving (as of 1990) UK soldiers of WWI forever blinded by mustard gas or of the 30,000-60,000 Iranian veterans living with post-exposure disorders due to chemical weapons—much less poor, martyred Baseej fighter Magid Azam who ended his life coughing up his lungs in a Tehran hospital.

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107 “Mustard Gas Used By Iraq in War with Iran,” cia_62648_61898_01.txt
Comparing Force Ratios to Casualty Exchange Ratios

Christopher A. Lawrence

There are three versions of force ratio versus casualty exchange ratio rules, such as the three-to-one rule (3-to-1 rule), as it applies to casualties. The earliest version of the rule as it relates to casualties that we have been able to find comes from the 1958 version of the US Army Maneuver Control manual, which states:

“When opposing forces are in contact, casualties are assessed in inverse ratio to combat power. For friendly forces advancing with a combat power superiority of 5 to 1, losses to friendly forces will be about 1/5 of those suffered by the opposing force.”

The RAND version of the rule (1992) states that “…the famous ‘3:1 rule’, according to which the attacker and defender suffer equal fractional loss rates at a 3:1 force ratio if the battle is in mixed terrain and the defender enjoys ‘prepared’ defenses…”

Finally, there is a version of the rule that dates from the 1967 Maneuver Control manual that only applies to armor that shows:

<table>
<thead>
<tr>
<th>Combat Ratio</th>
<th>Tank Losses (per platoon of 5 tanks) per Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attacker</td>
<td>Defender</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

As the RAND construct also applies to equipment losses, then this formulation is directly comparable to the RAND construct.

Therefore, we have three basic versions of the 3-to-1 rule as it applies to casualties and/or equipment losses. First, there is a rule that states that there is an even fractional loss ratio at 3-to-1 (the RAND version), Second, there is a rule that states that at 3-to-1, the attacker will suffer one-third the losses of the defender. And third, there is a rule that states that at 3-to-1, the attacker and defender will suffer the same losses as the defender. Furthermore, these examples are highly contradictory, with either the attacker suffering three times the losses of the defender, the attacker suffering the same losses as the defender, or the attacker suffering 1/3 the losses of the defender.

Therefore, what we will examine here is the relationship between force ratios and exchange ratios. In this case, we will first look at The Dupuy Institute’s Battles Database (BaDB), which covers 243 battles from 1600 to 1900. We will chart on the y-axis the force ratio as measured by a count of the number of people on each side of the forces deployed for battle. The force ratio is the number of attackers divided by the number of defenders. On the x-axis is the exchange ratio, which is measured by a count of the number of people on each side who were killed, wounded, missing or captured during that battle. It does not include disease and non-battle injuries. Again, it is calculated by dividing the total attacker casualties by the total defender casualties. The results are provided below:

As can be seen, there are a few extreme outliers among these 243 data points. The most extreme, the Battle of Tippermuir (1 Sep 1644), in which an English Royalist force under Montrose routed an attack by Scottish Covenanter militia, causing about 3,000 casualties to the Scots in exchange for a single (allegedly self-inflicted) casualty to the Royalists, was removed.

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1 FM 105-5, Maneuver Control (1958), 80.
from the chart. This 3,000-to-1 loss ratio was deemed too great an outlier to be of value in the analysis.

As it is, the vast majority of cases are clumped down into the corner of the graph with only a few scattered data points outside of that clumping. If one did try to establish some form of curvilinear relationship, one would end up drawing a hyperbola. It is worthwhile to look inside that clump of data to see what it shows. Therefore, we will look at the graph truncated so as to show only force ratios at or below 20-to-1 and exchange ratios at or below 20-to-1.

Again, the data remains clustered in one corner with the outlying data points again pointing to a hyperbola as the only real fitting curvilinear relationship. Let's look at little deeper into the data by truncating the data on 6-to-1 for both force ratios and exchange ratios.

As can be seen, if the RAND version of the 3-to-1 rule is correct, then the data should show at 3-to-1 force ratio a 3-to-1 casualty exchange ratio. There is only one data point that comes close to this out of the 243 points we examined.

If the FM 105-5 version of the rule as it applies to armor is correct, then the data should show that at 3-to-1 force ratio there is a 1-to-1 casualty exchange ratio, at a 4-to-1 force ratio a 1-to-2 casualty exchange ratio, and at a 5-to-1 force ratio a 1-to-3 casualty exchange ratio. Of course, there is no armor in these pre-WWI engagements, but again no such exchange pattern does appear.

If the 1958 version of the FM 105-5 rule as it applies to casualties is correct, then the data should show that at a 3-to-1 force ratio there is 0.33-to-1 casualty exchange ratio, at a 4-to-1 force ratio a .25-to-1 casualty exchange ratio, and at a 5-to-1 force ratio a 0.20-to-5 casualty exchange ratio. As can be seen, there is not much indication of this pattern, or for that matter any of the three patterns.

Still, such a construct may not be relevant to data before 1900. For example, Lanchester claimed in 1914 in Chapter V, “The Principal of Concentration,” of his book *Aircraft in Warfare*, that there is greater advantage to be gained in modern warfare from concentration of fire. Therefore, we will tap our more modern Division-Level Engagement Database (DLEDB) of 675 engagements, of which 628 have force ratios and exchange ratios calculated for them. These 628 cases are then placed on a scattergram to see if we can detect any similar patterns.

Even though this data covers from 1904 to 1991, with the vast majority of the data coming from engagements after 1940, one again sees the same pattern as with the data from 1600-1900. If there is a curvilinear relationship, it is again a hyperbola. As before, it is useful to look into the mass of data clustered into the

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3 F. W. Lanchester, *Aircraft in Warfare: The Dawn of the Fourth Arm* (Lanchester Press Incorporated, Sunnyvale, Calif., 1995), 46-60. One notes that Lanchester provided no data to support these claims, but relied upon an intellectual argument based upon a gross misunderstanding of ancient warfare.
corner by truncating the force and exchange ratios at 20-to-1. This produces the following:

![Graph of Strength Ratio vs Loss Ratio (Max 20:1)](image)

Again, one sees the data clustered in the corner, with any curvilinear relationship again being a hyperbola. A look at the data further truncated to a 10-to-1 force or exchange ratio does not yield anything more revealing.

![Graph of Strength Ratio vs Loss Ratio (Max 10:1)](image)

And, if this data is truncated to show only 5-to-1 force ratio and exchange ratios, one again sees:

![Graph of Strength Ratio vs Loss Ratio (Max 5:1)](image)

Again, this data appears to be mostly just noise, with no clear patterns here that support any of the three constructs. In the case of the RAND version of the 3-to-1 rule, there is again only one data point (out of 628) that is anywhere close to the crossover point (even fractional exchange rate) that RAND postulates. In fact, it almost looks like the data conspires to make sure it leaves a noticeable “hole” at that point. The other postulated versions of the 3-to-1 rules are also given no support in these charts.

Also of note, that the relationship between force ratios and exchange ratios does not appear to significantly change for combat during 1600-1900 when compared to the data from combat from 1904-1991. This does not provide much support for the intellectual construct developed by Lanchester to argue for his N-square law.

While we can attempt to torture the data to find a better fit, or can try to argue that the patterns are obscured by various factors that have not been considered, we do not believe that such a clear pattern and relationship exists. More advanced mathematical methods may show such a pattern, but to date such attempts have not ferreted out these alleged patterns. For example, we refer the reader to Janice Fain’s article on Lanchester equations, *The Dupuy Institute’s Capture Rate Study, Phase 1 & II*, or any number of other studies that have looked at Lanchester.⁴

The fundamental problem is that there does not appear to be a direct cause and effect between force ratios and exchange ratios. It appears to be an indirect relationship in the sense that force ratios is one of several independent variables that determine the outcome of an engagement, and the nature of that outcome helps determines the casualties. As such, there is a more complex set of interrelationships that have not yet been fully explored in any study that we know of, although it is briefly addressed in our *Capture Rate Study, Phase I & II*.

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An Analysis of the Morale Table in the TNDM

Alexander Dinsmoor and Christopher A. Lawrence

According to the *TNDM Manual of Rules and Procedures*, the Combat Effectiveness Value (CEV) of a unit includes leadership, training, experience, logistics effectiveness, technology, morale, and luck and chance. Yet, within the TNDM and the older QJM, there has always been a separate morale table. This raises the question as to when to use this value and whether to use it in conjunction with CEV?

Col. Trevor N. Dupuy suggested settings for morale in his description of the QJM in *Numbers, Predictions and War*. The same chart was reproduced in the appendix of the *TNDM Manual*. Neither *Numbers, Predictions and War* nor the *TNDM Manual* give instructions for adjusting morale in the QJM or TNDM. Descriptions, or even the existence of a morale parameter separate from the combat effectiveness value (CEV), are absent from the *TNDM User’s Guide* (including its non-inclusion in a screenshot of the Rate Modifiers and Set Piece Factors menu on page 37, which was from an earlier version of the TNDM). The TNDM includes an option to adjust the morale of the attacker’s or defender’s forces on the Rate Modifiers and Set Piece Factors menu in version 2.06 of the TNDM.

This chart appears as table 12 in Appendix B-14 in the *TNDM Manual* and on page 231 in *Numbers, Predictions and War*:

<table>
<thead>
<tr>
<th>Morale Level</th>
<th>Morale Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>1.0</td>
</tr>
<tr>
<td>Good</td>
<td>0.9</td>
</tr>
<tr>
<td>Fair</td>
<td>0.8</td>
</tr>
<tr>
<td>Poor</td>
<td>0.7</td>
</tr>
<tr>
<td>Panic</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Morale acts upon the model the same way that CEV does, which is entirely logical as Morale is a component of CEV. As there is no detailed description in the *TNDM Manual*, we decided to test the results of adjusting morale on the results of the Battle of Sarimbun Beach, part of the Malaya campaign in World War II. Initially, both sides’ morale was lowered the same amount; this lowered each side’s p-values equally and, therefore, did not change the results. For the next test, the Japanese morale was kept at 1 and the Australians’ morale was lowered to each of the levels suggested in the *TNDM Manual*. Morale again acted as a divisor on the p-value of the side that was adjusted. Therefore, lowering the Australians’ morale from 1.0 to 0.9 causes them to lose the 10% of their p-value. This indicates that the morale factor operates like the CEV, adjusting the total p-value. This was confirmed when the CEV was adjusted in place of morale. Lowering CEV from 1.0 to 0.9 caused a 10% loss of p-value. Therefore, setting one side’s CEV to 1.43 has the same effect as lowering its opposition’s morale to poor (0.7), and morale value of panic (0.2) has the same effect as setting one side’s CEV to 5. Like the CEV, morale can be adjusted to any value, not just the values suggested in Numbers, Predications and War and table 12 of the TNDM manual.

It appears that morale remains in the TNDM primarily as a legacy table. As morale is a component of CEV, we strongly recommend using CEV instead of morale. The results of the tests suggest that adjusting morale, particularly in a drastic fashion, without good reason, can significantly affect results. In fact, lowering the Japanese morale to 0.2 produced the only outcome we tested in which the Australians won the Battle of Sarimbun Beach.

We suspect this table was developed in part because Colonel Dupuy was trying to establish values for each independent component of CEV. As there was no clear way of doing so, this effort was abandoned, and he instead focused on CEV and the value to best work with. In the eight years I worked with Trevor Dupuy (from 1987-1995), I do not recall a single case of someone using the morale factor in model runs.

Probably the only time we would advise using the morale function is if there were a situation in which the morale had clearly changed (declined) for one side since the initial engagements had been modeled (assuming one was doing a series of engagements) or was starting to collapse. Adjusting morale might be applicable in cases where one side’s morale completely collapsed—for example, the Iraqi forces in the 1991 Gulf War. In this case, you are adding in a morale factor to reflect a change above and beyond the morale that was originally reflected in the CEV differences. There, it can be used with judiciousness in certain cases, but it is not recommended for use with most analysis.
Alexander Dinsmoor graduated from Goucher College with a BA in Political Science in 2005. During his course of studies, Mr. Dinsmoor had the opportunity to intern in the US House of Representatives on Capitol Hill and in the British Parliament’s House of Commons. During a study abroad at the London School of Economics, Mr. Dinsmoor authored a thesis on the future of the UK’s nuclear deterrent.

Mr. Dinsmoor is originally from Boston, MA, but moved to Washington DC in the winter of 2005 to pursue a job in a political science- or history-related field. After working with organizations as diverse as union groups and the Heritage Foundation, Mr. Dinsmoor joined The Dupuy Institute in November 2006.

Mr. Dinsmoor’s first project with The Dupuy Institute was the Modern Insurgency Spreadsheets (MISS) database of insurgencies, where he focused on African insurgencies. He was also tasked with editing the final versions of the Phase IV reports. In the past year, Mr. Dinsmoor has worked on transitioning the MISS sheets into the ACID database. Most recently Mr. Dinsmoor was involved in demonstrating the TNDM’s capabilities as part of our training course for the TNDM.

Mr. Dinsmoor lives in College Park, Maryland. He enjoys reading history, foreign films and his vegetable garden.