Chapter Seven

The Emergence of Postmodern War: World War II

By means of technique man changes not only the method by which he thinks but the content of what he thinks about.
—William Blanchard (quoted in Sherry, 1987, p. 248; emphasis in original)

World War II: The Last Modern War

World War II was unique, not just quantitatively, but in technological quality as well. The strategic bombing technology (planes, bombs, organization) that manufactured the firestorms of Dresden and Tokyo, as destructive as Hiroshima and Nagasaki, is one example. But most significant was the development of nuclear weapons and computers. The atomic bomb changed the parameters of lethality forever. Computers not only made the A-bomb industry possible, they also changed ballistics and logistics and have made over command, control, communications, and intelligence (C3I). In some aspects World War II was a postmodern war, especially as concerns these two weapons and the whole system of strategic bombing. But fundamentally World War II was a modern war because it continued modern war's quest for totality, up to and including Hiroshima.

It is with good reason that World War II is often called the physicists' war, for physics made the total weapon, atomic bombs, possible. Yet, as valid as that label is, it disguises somewhat the pervasive role of formal logical systems and other aspects of technoscience. The scientific and bureaucratic management of soldiers, the press, domestic intelligence, and scientists, which got such a good start in World War I, became full-blown psychological testing, a gigantic propaganda apparatus, an international intelligence bureaucracy, and a vast network of secret military research labs in World War II. War was mechanized, not just with blitzkriegs, so dependent on radios, trucks, tanks, and airplanes, but in its very organization.
In many cases it was mechanized thinking, instead of machines themselves, that came first. Consider scientific management and operations research. Both of these formal/logical systems are rule bound, explicitly defined, and involve a great deal of mathematical calculation. They were carried out originally on mechanical IBM punch card machines, then with the aid of electric calculators, and finally by electronic computers.

It was in the logistics of producing and moving vast numbers of soldiers and war matériel that most successes for formal logic were recorded. The human ability to control and manage large numbers of things grew tremendously, thanks to these formalizations of bureaucratic behavior. This management included the soldiers' psyches as well. The U.S. Army's Research Branch of the Special Services Division conducted a series of attitude surveys that, according to the historians of sociology Robert Lynd and John Madge, were supposed "to sort out and to control men for purposes not of their own willing." Many social scientists worried that the whole of sociology would become mobilized for solving the "managerial problems for industry and the military" (quoted in M. R. Smith, 1985a, p. 14; see also Buck, 1985).

The increasing management of soldiers was matched by official control of the press (Knightley, 1975), the creation of a large international intelligence system controlled by the United States (Donner, 1980, pp. 52–68; R. H. Smith, 1977), and by the military mobilization of American scientists to an unprecedented degree (Flamm, 1987, pp. 6–7; Kevles, 1987). Michael Sherry, in Preparing for the Next War, notes that military research went from $13 million in 1939 to $1.5 billion by 1944 (1977, p. 126). Many scientists who worked for the military were sure that civilian scientists would make war much more effective. As the science writer J. Crowther and the scientist R. Whiddington put it in Science at War, their semiofficial history of British science in World War II:

> The romantic conception of war is becoming out of date. It is not consonant with the systematic, rational, scientific kind of warfare which is evolving from the inter-penetration of war and science. . . . For the traditional romanticism of war is the contrary of the civilian scientific spirit, and it is therefore natural that when the scientist begins to join in the conduct of war, he enters into it as a civilian. That is why the directors of operational research are generally civilians, and one reason why war in the future will tend more and more to be conducted in a civilian spirit. (1948, pp. 119–120)

It was to be a very unromantic war. And perhaps its least romantic aspect and the best example of mechanized thinking, wed to high technology and scientistic technological fanaticism, was the allies' strategic bombing policy. To understand the emergence of postmodern war in World War II, it is
necessary to trace the development of strategic bombing from its beginnings in the dropping of hand grenades on tribal villages to the plans for intercontinental nuclear war, the reductio ad absurdum of total war.

**The History of Strategic Bombing**

The airplane appears, and a . . . new military philosophy [is] centered upon it. Then nuclear weapons and rocket vehicles come along, and these create wholly new conditions . . . including certainly possibilities of unprecedented evil resulting from war.

—Bernard Brodie (1973, p. 243)

I still remember the effect I produced on a small group of Galla tribesmen massed around a man in black clothes. I dropped an aerial torpedo right in the center, and the group opened up just like a flowering rose.

—Mussolini's son Vittorio describing combat in Ethiopia (quoted in Virilio, 1990, p. 19)

The first real theorist of strategic bombing was the Italian Guilio Douhet. In 1909 Wilbur Wright visited Italy with an airplane and Douhet was inspired with the idea of air power (Holley, 1988, p. 22). He felt that new technologies meant new types of war. "The form of any war . . . depends upon the technical means of war available" (quoted in Holley, 1953/1983, pp. 12–13). Even before World War I he was calling for strategic bombing, so he deserves some credit for the sad fact that it was Italians who first dropped bombs from planes onto people. In October 1911, during the Italian–Turkish War, they bombed Turkish troops and Arab tribesmen in Libya. The pilots were probably trained by the Wright brothers, whose aggressive advocacy of military air power had earned them the Italian Air Force's training contract in 1909 (Donnini, 1990, pp. 45–51). A year later the French Air Force used terror bombing to put down an anticolonial rebellion in Morocco. Targets included villages, markets, flocks of sheep, and fields of grain (Kennett, 1982, p. 15).

During World War I the Italians ran one of the largest bombing campaigns but they were matched by the Germans and, later, the British. Strategic bombing was first tried on October 11, 1914, when a couple of German Taubes dropped 22 bombs on Paris, killing 3 citizens, wounding 19, and scratching Notre Dame (Ekstein, 1989, p. 158). Almost a year later, on September 8, 1915, Zeppelin L-15 of the German Army bombed a number of London neighborhoods causing 72 casualties, including 17 astounded drinkers at the Dolphin public house on Red Lion Street (Dyer, 1985, p. 84).

Only a few thousand tons of bombs were dropped on strategic targets in World War I, an amount soon matched in various colonial bombing cam-
paigns by France and Britain. The French even developed a fighter-bomber for just such a role, *Type Coloniale*, while the British initiated in parts of the empire a system of air rule called "Control without Occupation." In 1922 Air Marshal Sir John Salmond became the first air officer to command a combined invasion force, when he took charge of all British units in Iraq. The British also waged an air campaign against the Pathan (Pashtun) people on India's North-West Frontier, which included the bombing of villages and reservoirs. U.S. Marines bombed Ocotal and other Nicaraguan towns in 1927 (Franklin, 1988, pp. 88–89, 97). But these were just colonial bombings and so drew little notice. For many, bombing "civilized" people was still criminal. The strategic bombing of Guernica and Barcelona by the Germans during the Spanish Civil War, for example, was widely condemned.

On the day World War II started, September 1, 1939, President Franklin D. Roosevelt even issued an "urgent appeal" that "under no circumstances" should civilians or unfortified cities be bombed from the air. He called such bombing "inhuman barbarism." The year before, Secretary of State Cordell Hull had said of the bombing of Barcelona, "No theory of war can justify such conduct." That same year the U.S. Senate had condemned the "inhuman bombing of civilian populations." Yet, while American politicians were denouncing these attacks, the U.S. Army Air Force was itself preparing for strategic bombing, developing the new planes, bombs, institutions, and doctrines that would make the United States the world's leading strategic bomber by 1945 (Franklin, 1988, p. 101; Millis, 1956, p. 241).

Before World War II and during the early phony war stage, the idea spread of strategic bombing as a knockout blow aimed at the will, and perhaps the economic heart, of the opponent. But as the bombing surveys found after the war, the Germans, the British, and the Americans all failed to achieve the predicted success with their strategic bombing despite the great effort expended in men and material. Bombing stiffens civilian morale and does not totally disrupt production. Although it has yet to work, and it means killing civilians, strategic bombing still has many believers. It has been tried often, recently in locales as different as Vietnam, Afghanistan, Chechnya, and Iraq.

Freeman Dyson, later a well-known physicist, worked for Bomber Command during World War II, and he noticed early on that not only was his work not effective but it was also immoral (1984, p. 60). Dyson remarks with approval that Winston Churchill blocked the building of a monument for Bomber Command, although it was the only command without one. Bernard Brodie (1946, 1973) and John Kenneth Galbraith (1969a, b, 1981) were involved in studying the effects of the strategic bombing by the United States and United Kingdom and have written about their views extensively. Albert Speer, from his different perspective, reached similar conclusions, as is detailed in his memoirs (1970).
But the appeal of strategic bombing is so strong that despite its failure to be a decisive weapon, its supporters refuse to stop thinking it is. Science fiction writers and military theorists who believed in strategic bombing had long felt that mere explosive bombs would not be destructive enough to win a war. They argued that poison gases and incendiaries would increase the power of the bombing and achieve the desired effect (Franklin, 1988). As the use of poison gas was restricted for various reasons, especially the fear of retaliation, it was left to incendiaries to vindicate strategic bombing. With the help of scientists, military aviators calculated that by using the right mix of incendiaries and explosives on the right target at the right time a unique, man-made, weather condition could be created: a firestorm. They were correct.

The first successful firestorm was made in Hamburg, Germany. Operation Gomorrah, four assaults in late July and early August of 1943 by an RAF force of 731 attacking bombers, started the firestorm when the air heated to 800 Celsius, creating a gigantic blast furnace effect over the city. Most of the victims asphyxiated or were burnt into Bombenbrandschrumpfleischen (incendiary-bomb-shrunken bodies). More than 40,000 Germans died. The Japanese were next.

The Burning of Japan

American policy is to expend machines rather than men.
—Intelligence Officer, 20th Air Force
(quoted in Sherry, 1987, p. 192)

The idea of burning Japan had long been popular in the United States. In an article in the mass circulation weekly Liberty from January 30, 1930, entitled “Are We Ready for War with Japan?” Billy Mitchell, commented that Japanese cities were “an ideal target for air operations.” A horrific drawing of the bombing of Japanese civilians illustrates the first page of this article (Franklin, 1988, p. 70). In 1943 Walt Disney even made a full-length cartoon about it, Victory Through Air Power, which begins with a clip of Billy Mitchell giving a speech in favor of strategic bombing.

Disney was inspired by a book of the same title as the cartoon published in 1942 by the head of Republic Aviation Corp., the Russian emigré Alexander P. de Seversky. Seversky called for “a war of elimination” against Japan. Disney’s animation was exuberant, showing armies of bombers burning acres of cities without any human suffering. The climax is the transformation of the bombers into an American eagle that then claws the Japanese octopus to death. In a review James Agee called it “gay dreams of holocaust.” Bruce Franklin comments on the end of the film: “As the audience beholds the
smoldering remains of this make-believe nation, it hears the swelling strains of 'America the Beautiful.' Then across the screen is emblazoned 'VICTORY THROUGH AIR POWER' " (p. 108).

But it took the U.S. Army Air Force and its scientific experts to make it happen. And the instrument was the 20th Air Force, commanded directly from Washington, D.C. by Gen. H. H. ("Hap") Arnold, and at the front, 21st Bomber Command, under Maj. Gen. Curtis LeMay.

The German firestorms, for others were created after Hamburg, were closely studied by the Americans. One expert was a young OSS (Office of Strategic Services) analyst, Charles Hitch. After a trip to England he recommended using incendiaries on Japan. In Washington, D.C., he managed the "physical vulnerability directorate" in the Pentagon and worked on several bombing studies of Japan. One of these, finished before the fire-bombing of Japan started, predicted half a million fatal casualties, almost 8 million people "dehoused," and a 70 percent destruction rate on the targets. "The attacks assumed in this study would effect a degree of destruction never before equaled," the report enthused. Despite this, in the conclusion it was admitted that "it is unlikely that output in any one important [warmaking industrial] category will be so reduced as substantially to affect front line strength." In other words, despite killing half a million people it would not hurt Japan's ability to fight at all. It was to be terror bombing plain and simple to break the will of the Japanese to fight.¹

Other scientist-analysts went out of their way to push for the fire-bombing as well. Dr. R. H. Ewell wrote a memo to Vannevar Bush, Director of the Office of Scientific Research and Development, that called "incendiary bombing of Japanese cities" a "golden opportunity of strategic bombardment in this war—and possibly one of the outstanding opportunities in all history to do the greatest damage to the enemy for a minimum of effort." He went on to bitterly complain that the Air Staff and 20th Air Force planners were blocking firebombing.² He need not have worried.

General LeMay became convinced that the opportunity of burning down Japan was too great to pass up. Not that it would win the war, but rather because it would prove "the power of the strategic air arm." In a revealing Telecon memo he sent to Brig. Gen. Lauris Norstad during an argument over how hard they were working the air crews, he admitted as much.

Both my surgeon and my wing commanders are convinced that to require this rate [the "short-term" rate of 80-plus combat hours per month] for a six-month period might burn out my crews. . . . In choosing between long-term and short-term operating policy I am influenced by conviction that the present state of development of the air war against Japan presents the AAF for the first time with the opportunity of proving the power of the strategic air arm. . . . Though naturally reluctant to drive my force at
The incendiaries themselves were made by the Army Chemical Warfare Service, the National Defense Research Committee, and the petrochemical industry. Much of the experimental work was directed by the Harvard chemist Louis Fieser. Fieser was something of an enthusiast. He tried to teach bats to carry tiny incendiaries so that when dropped from bombers they would nest in attics and start many efficient little fires. He abandoned this idea after he burned up the theater, officer’s club, and a general’s car in tests at the Army airfield at Carlsbad, NM (Sherry, 1987, p. 226). But strategic bombing was not just a matter of technology; it was first of all a system, and humans were key components.

To understand this a closer look at one analyst’s history will be helpful. This young man was a professor at Harvard Business School when the war began. He was an expert in bargaining theory, but his work for the 20th Air Force was calculating the various options and necessities of strategic bombing.

For example, in one of his reports in 1945, he points out that at the possible “loss rates” of earlier months, the “proposed activity rates” of the 20th Air Force could not be sustained. Note the language of economics, as well as of mathematics, that frames the analysis:

At the loss rates sustained during 1 March to 18 March and with a tour of duty allowing a 70% chance for survival, the present aircraft and crew replacement planning factors will support the proposed activity rates. However, an increase in the loss rate to the levels of January and February would require an increase in the aircraft replacement requirements and either an increase in the crew replacement rate or a lengthening of the tour of duty.

He does advocate that the replacement rate be picked up, if possible, which was the recommendation accepted. One of the more interesting graphics in this report is called “Tables of Survival.” He shows how at the loss rate of 1.1 percent per sortie, a 30-sortie tour would be a loss rate of 26 percent, “well under the AAF standard of 35 to 50%.” In other words, the crews can expect a 1 in 4 chance of being shot down before they complete their tour of duty.

In another report in the same month he calls these crews “inventory” and notes that their survival rate was 65 percent over the previous six months. For this young Harvard professor, whose survival rate was always significantly above 65 percent, this was a scientific, even economic, calculation, with no morality or fuzziness at all about it.

And as he calculated his inventory of air crews versus their losses, he
also advocated a switch from precision bombing to firebombing because of its greater "efficiency." His voice, no doubt, did not yet carry much weight. For during World War II he was only a small part of the strategic bombing system. But later, Robert Strange McNamara would run a war of his own.

When McNamara was first commissioned a captain he began doing logistical analysis on the operations of B-17s (in England for four months) and of B-29s (in Kansas for six months). During this period, 1943, he met General LeMay. In April 1944 McNamara was sent to Calcutta, India, to work directly with the strategic bombing force. Six months later he was made a lieutenant colonel, and that October he returned to Washington, D.C., and the Office of Management (Trewitt, 1971, pp. 36-40).

His military service was working for the Statistical Control Office with human computers and IBM electrical-mechanical machines to keep track of various key variables for Army Air Force projects. All of his most important postings were to help strategic bombing, especially the operations of LeMay's Bomber Command, the unit that perfected massive firebombing on Japan. McNamara's commanding officer during one assignment said,

the genius of the operation was the young McNamara, putting all the infinitely complicated pieces together, doing program analysis, operation analysis, digesting the mass of facts which would have intimidated less disciplined minds, less committed minds, making sure that the planes and the crews were readied at roughly the same time. Since all this took place before the real age of computers, he had to work it out himself. He was the intelligence bank of the project, and he held the operations together, kept its timing right, kept it all on schedule. (quoted in Halberstam, 1972, p. 280)

McNamara was only one of many such analysts, and they weren't always welcomed by the Army Air Force. As Michael Sherry notes in his history of the rise of U.S. air power:

On occasion, the effort to quantify the air war aroused suspicions, particularly among some professional officers . . . [but no] one successfully challenged the general approach whereby numbers measured results, informed rhetoric, and displaced subjective analysis. (1987, pp. 232–233)

Sherry shows that while the military often resisted specific operations research (OR) analysis, and though it certainly challenged the idea of any certainty in bombing, and despite the fact that "military commanders often made critical decisions by seat-of-the-pants methods," the basic assumptions of bomb/destroy/bomb/win, measured in weights and missions was never challenged. This worldview began to colonize the vision of the Air Force officers:
By the language they used, the methods they employed, and the concerns they focused upon, the experts helped change the content of what decision makers in the air force thought about, permitting them to see air war less as a strategic process aiming at victory and more as a technical process in which the assembly and refinement of means became paramount. They did so in part because the refinement of means and the achievement of destruction were what operations research could most effectively achieve. (p. 234)

Not only was military utility replaced by operational utility, but the military morality of “just war” and “manly combat” was supplanted by an industrial, amoral approach: mass production killing:

The rhetoric and methodology of civilian expertise also defined goals by the distance they interposed between the designers and victims of destruction. The more sophisticated the methods of destruction became, the less language and methods of measurement allowed men to acknowledge the nature of that destruction. A dehumanized rhetoric of technique reduced the enemy to quantifiable abstractions. Statistics of man-hours lost and workers dehoused objectified many of the enemy’s experiences and banished almost altogether one category, his death. (pp. 234–235)

By late in the war, there were 400 OR workers in the Army Air Force. They spread their calculations and their technical perspective relentlessly. One key part of this discourse is to refuse to focus on actual enemy deaths, especially civilian deaths. For example, the Committee of Operations Analysis (COA), in its report on the potential of incendiary attacks, made no estimate of casualties. Instead, it preferred to measure the potential damage with other statistics: 180 square miles of urban areas devastated, and 12 million people, or 70 percent of the total population in the 20 cities, rendered homeless (p. 228).

Most analysis was couched in safe language. Destroying residential neighborhoods was called “dehousing.” It was

the favorite euphemism for a variety of virtues perceived in an incendiary assault, some spelled out—workers’ absenteeism, lower morale, paralyzed systems—some usually left unspoken: the maimed bodies and bewildering toll of the dead. Target analysts recognized that such an assault would inflict scant damage on primary military and industrial establishments. But few questioned the moral or strategic wisdom of the planned campaign. (p. 232)

Even the weather was enlisted in maximizing enemy casualties. Helmut Landsberg, a German-born meteorologist on the 20th Air Force staff, suggested firebomb attacks be timed with cold weather to precipitate influenza
and other serious epidemics. Landsberg, or other weather staffers of the 20th Air Force, also called for renewed firebombing in the spring of 1945 because summer was coming and “Favorable fire weather conditions have almost never occurred from June to October at Tokyo” (quoted in Sherry, 1987, pp. 232, 299).

This technological fanaticism, which allowed the Allies to burn whole cities, was not totally different from the fanaticism of the Axis. True, the Allies, especially the United States, preferred to spend machines and bombs instead of men, and preferred destruction from a distance. But the Germans also had missiles, and strategic bombing of their own. Both sides were capable of suicide battles, the United States and Allies more in the beginning of the war, the Axis toward the end of the war. Both sides were remarkably methodical toward their mass destruction ends. Reading about the logistics of the Nazi Holocaust, the working of Stalin’s Gulag, and the logistics of the Strategic Bombing campaigns, it is disturbing just how similar they were—especially in their denial of what they were doing. It is true that the Nazi concentration camps killed more people, and on particularly odious grounds, and Stalin’s long-running terror probably killed the most. But when one calculates that perhaps as many as 2 million civilians were killed directly and indirectly by Allied strategic bombing, a comparison does become possible.

Strategic bombing, “destruction disguised as technique,” is what Sherry calls “sin of a peculiarly modern kind” and which he defines as “technological fanaticism,” the product of two distinct but related phenomena: one—the will to destroy—ancient and recurrent; the other—the technical means of destruction—modern. Their convergence resulted in the evil of American bombing. But it was sin of a peculiarly modern kind because it seemed so inadvertent, seemed to involve so little choice. Illusions about modern technology had made aerial holocaust seem unthinkable before it occurred and simply imperative once it began. It was the product of a slow accretion of large fears, thoughtless assumptions, and at best discrete decisions. (1987, p. 254)

These “discrete decisions” resulted in the single greatest night of killing in the war, the Tokyo raid of March 9, 1945. Sixteen square miles and more than 84,000 people were burned. The headquarters for that raid was Washington, D.C. Strategic bombing was run from afar. RAF HQ was out in the English countryside, as were the Bomber Commands for the United States. In the Pacific campaign, General Arnold commanded the 20th Air Force from the Pentagon. Wings had bases on various Pacific islands.

The main reasons that control of the burning of Japan stayed in the U.S. capital were to maximize good public relations and to centralize operations research and bureaucratic management. The Army Air Force ran several
large public relations campaigns, and it was always careful to release information so that it helped, or at least didn't hinder, the campaign for an independent Air Force.

The ultimate step in strategic bombing was, of course, the atomic bomb. "Working on the bomb instilled a sense of ultimate potency, a triumph of man over nature" (quoted in Sherry, 1987, p. 202). Some scientists and diplomats saw the invention of the bomb as the ultimate weapon that would now finally make modern war impossible. George Kennan, for example, said:

> The atom has simply served to make unavoidably clear what has been true all along since the day of the introduction of the machine gun and the internal combustion engine into the techniques of warfare . . . that modern warfare in the grand manner, pursued by all available means and aimed at the total destruction of the enemy's capacity to resist, is . . . of such general destructiveness that it ceases to be useful as an instrument for the achievement of any coherent political purpose. (1961, p. 391)

What Kennan didn't realize was that a new type of war would come out of strategic bombing, a type of war symbolized by atomic weapons. Along with this new war, came a new type of militarism that united, for the first time really, science, technology, industry, and war. During World War II, the Nazis and Japanese never mobilized their economy as fully as did the United States and the United Kingdom. After noting this, Sherry goes on to compare Allied industrialism with Nazi and Japanese militarism:

> Economic power was not an alternative to military prowess but another method of expressing it. What happened in the Allied nations was not the decline of militarism or its failure ever to rise in those countries but its transformation. They departed from the path of militarism in the narrow sense that traditional military institutions, elites, and the values associated with them did not dominate. In another, broader sense—the willing enlistment of the broadest array of national energies and elites into the machine of war-making—militarism triumphed in the Allied powers to an exceptional degree, in a variation of it which Alfred Vagts has called "civilian militarism." (1987, p. 193)

Civilian militarism, to quote Vagts, "may be defined as the interference and intervention of civilian leaders in fields left to the professionals by habit and tradition" (1959, p. 193). Vagts noted that often

> Civilians not only had anticipated war more eagerly than the professionals, but played a principal part in making combat, when it came, more absolute, more terrible than was the current military wont or habit. (p. 463)
This is certainly not an uncommon phenomenon. But actually, it seems a little more complex. The military takes on scientific, technological, and management perspectives and the scientists, engineers, and business managers take on military characteristics. Sperry noted how the Army Air Force, especially General Arnold, typified this new synthesis:

As Arnold's interest in new technologies suggested, what characterized the Anglo-Americans at war was the coalescence, not the divergence, of civilian and military purpose and values. Military elites embraced civilian expertise, civilian elites embraced military purposes. (Sherry, 1987, pp. 193-194)

The first full fruit of this embrace was operations research.

**The Spread of Operations Research**

Systems theory is the latest attempt to create a world myth based on the prestige of science. . . . The basic thought forms of systems theory remain classical positivism and behaviorism. As epistemology, it leaves philosophy no further along in resolving the Cartesian dualism; it attempts to resolve this dualism by mechanizing thought and perception, or rather by constructing mechanical models of thought and perception.

—Lilienfeld (1979, pp. 249-250)

According to Crowther and Whiddington, authors of *Science at War*, "The development of operational research was one of the chief scientific features of the war" (1948, p. 91). Even more, they claim that "through it, science entered into warfare in a new degree," its major conception being "the reduction of war to a rational process" (p. 119).

It was not a new plan. As far back as Sun Tzu, military thinkers have been trying to rationalize war. Historian Irving B. Holley, Jr., argues that history is replete with examples of military commanders—and industrial managers—who have used a form of Operations Research to improve their effectiveness. But not until the era of World War II did OR acquire its elaborate institutional basis and widespread military application, beginning with the Air Ministry unit established in 1937. (1969, p. 90)

It was during World War I, actually, that there was the first systematic application of operations analysis (OA) to military problems. Later, operations analysis was termed operations research, then systems analysis, as it is still called, although now it also blends into cybernetics, game theory, and
crisis management. This first application of operation analysis was British mathematician F. W. Lanchester's work, reported in his 1916 book *Aircraft in Warfare* and first applied in the hunting of submarines (Brodie and Brodie, 1973, pp. 271–272).

Lanchester's efforts also marks the beginning of attempts to quantify the deciding elements of battle into "Laws of Combat." Lanchester's equations, and the numerous revisions since then, are at the heart of many war games, strategic debates, and policy decisions. They are based on the assumption that the dynamics of combat can be scientifically analyzed because war concerns a comprehensible body of natural phenomena that may be treated scientifically, not merely in a general and qualitative way, but more especially in the specific, theoretical, and quantitative way so effectively pursued in the study of physical phenomena. (Brackney, 1959, p. 30)

Yet, when one looks at the history of the "Laws of Combat" it becomes clear that despite years of research, numerous formulations, and numberless studies the "Laws" are more controversial than ever. They have never been validated empirically or historically and are often flawed by simple mathematical errors as well (Lepinwell, 1987).

The term *operational research* itself can be traced back to 1937 and the British research team working at Bawdsey, the "home" of radar (Crowther and Whiddington, 1948, p. 92). But most of the assumptions go back to Lanchester, as mentioned above. Biologist Solly Zuckerman was an early advocate. He declared that military operations were "an experiment of a crude kind" and that war was a predictable science and not an art (quoted in Allen, 1987, p. 132).

It seems some scientists and soldiers can't help believing that if a problem is given numerical values and framed as an equation or two it is suddenly easier to solve:

*When the scientist examines an operational scheme, he frequently finds that the commonsense view of it is the correct one. But he backs his view by numerical proof. Thus the commander's decision, which may have been correct from the beginning, is transformed from an emotional judgment into an objective fact. In this way, operational research helps to prevent war being run by gusts of emotion, and hunches. (Crowther and Whiddington, 1948, p. 115)*

A fine trick to turn emotions into facts. Despite such magic, some of the "experiments" done by the scientists seem less than brilliant. The radar profile of birds was deduced by taking radar soundings of a dead bird hung from a balloon. Trip wires to protect units in the Pacific from Japanese infiltrators were tested "by stringing wires across routes traversed by the large
army of women cleaners found in all Ministry of Supply establishments either upright or on their knees with a scrubbing brush,” because these “modes of motion were considered typical of Jap movement.” Almost all the “experiments” were simple empirical tests; much of the rest of the analysis was paying close attention to details, such as how many rounds of machine gun ammunition were actually used on bomber sorties and counting the number of planes lost due to fire as compared to other damage (pp. 106–113).

The limitations of this kind of thinking are clear from looking at the work of Dr. Zuckerman and his colleagues J. D. Bernal and E. R. Garwood in predicting damage and casualties from strategic bombing raids. They bombed some goats, observed some German bombing results, and ran some statistical analysis until they could predict, with what enthusiasts describe as “a considerable degree of accuracy,” the casualties and other effects per ton of bombs. This work became a major justification for Britain’s own indiscriminate and supremely ineffectual night bombing of Germany. As it’s described in the semi-official history, “This feat gave the conception of a scientific bombing attack on Germany a new degree of reality and accuracy” (pp. 98–99).


Operations research did enjoy some success in improving antiaircraft aiming, in coming up with antisubmarine strategies, and in solving production and logistical problems. But when applied strategically, such as in the bombing of Germany and Japan, it was a failure. But it was successful enough culturally to lead to its institutionalization at the end of the war:

After . . . World War II . . . the services . . . committed to long-term operations research analysis. The Air Force organized the Rand Corporation . . . the Army established the Operations Research Office . . . the Navy . . . continued its war-time operations research team . . . At the level of the Department of Defense, a Weapons System Evaluation Group was established, along with an independent counterpart, the Institute for Defense Analysis. (Janowitz, 1971, p. 30)

This was just the institutionalization of a more fundamental shift in the postmodern military. The historical attitude of the military toward new technology, that of conservative resistance, had by the end of World War II swung 180 degrees so that now, in Janowitz’s words, “the arms race in nuclear and guided weapons has converted the armed forces into centers of continuous support and concern for innovation” (p. 27).

This change had but slight beginnings. In December 1942, General Arnold, the Deputy Chief of Staff of the Army and head of the Army Air
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Force, authorized a Committee of Operations Analysts to work with Air Staff. This committee was dominated by lawyers and businessmen: Elihu Root, Jr., Thomas Lamont of J. P. Morgan and Company, John Marshall Harlan, later of the Supreme Court, Fowler Hamilton, and the economist Edward Mason (Holley, 1969, pp. 189, 194). During the war, as mentioned above, there were over 400 such analysts.

After World War II, the headquarters OR staff was limited to 10 under LeRoy Brothers, and General LeMay's Strategic Air Command (SAC) had 15. Counting the other Air Force OR units as well, Brothers hired 6 physicists, 5 mathematicians, 23 statisticians, 7 engineers, and 1 educationalist (Holley, 1969, pp. 57-58, 93). But many more analysts were employed in outside think tanks, such as RAND. There was some struggle at first over the scientific status of OR, but the lawyers and even the social scientists were soon purged from the discipline:

One important element shaping the destinies of the Air Force OA organization was the Operations Research Society of America, commonly called ORSA. The founding of ORSA in 1952 clearly reflected the increasing appreciation for the work of analysts in both military and industrial circles. From its infancy, the Society favored a "hard science" approach. (p. 95)

The growth of cybernetics, which began to jell as a discipline during the war,7 backed by computers, lent further support to the "hard science" approach. Ellis Johnson of the Army-sponsored Operations Research Office, affiliated with the Johns Hopkins University, urged that social scientists be included in OR, but he was in a minority. "After virtually ignoring the tool during World War II" the Army was spending 10 million a year on OR by the mid-1950s (pp. 94-95). The moderately successful operations analysis of World War II, with teams of lawyers, engineers, and scientists, became much more scientistic and much less successful after the war. In a way, it went somewhat "insane," as the history of strategic doctrine will show in the next chapter.

Within the military domain, the scientists set higher goals. Instead of judging weapons, the scientists decided they should make the tactics and the strategies, to think through the whole system and make a systems analysis (SA):

Where the analysts of the war years had worked to make the performance of existing weapons optimal, the task now was to make future systems more effective. So the emphasis shifted to studies of alternative strategies, to the determination of requirements posed by these strategies, and to the promulgation of the detailed performance specifications demanded of each weapons system by the strategy selected. (p. 100; emphasis in original)
Unsurprisingly, World War II–style OR basically missed out on Vietnam, a war framed by SA. For a brief period in 1968 some OR teams got involved in analyzing appropriate B-52 sortie rates and the B-52’s use as a tactical weapon. Since they couldn’t analyze bombing effectiveness, they got into target selection (pp. 106–107). But how can you tell what is a good target to aim at if you don’t know which targets you can hit? OR was just too practical for Vietnam, a war that was not interested in how things were but how they were supposed to be.

Along with the systematic calculations of OA, OR, and SA, a whole new type of machine evolved out of World War II to help the human calculators—mechanical computers.

The Spread of Computing Machines

The very first attempts to build working computers, the calculating engines of Charles Babbage, were paid for with the very first military research and development grant—this one from the Royal Navy. While Babbage’s machines never worked, a modified Babbage Difference Engine, designed by Georg and Edvard Scheutz, did produce some of the astronomical tables Babbage was hired to make. Charles Xavier Thomas de Colmar “invented, perfected, and manufactured and sold the first commercially successful digital calculating machine” around the same time as Babbage worked. It was called the Arithmometer, and his customers included the French and British armed forces (I. B. Cohen, 1988, p. 125). Since these beginnings the connection between computing machines and military needs has been incredibly intimate and symbiotic.

By the end of the nineteenth century simple mechanical calculators were common. On land they were used by the artillery; on sea they directed naval guns. The workhorse of calculators for the United States during World War II was probably the analog Differential Analyzer, invented by Vannevar Bush. Two of them, built by the Moore School of the University of Pennsylvania, were installed at the Army Ordnance Department Ballistic Research Laboratory at the Aberdeen Proving Ground in 1934 (p. 135). But it wasn’t until World War II that the first true computers were developed, and it was at the military’s behest.

George Sitbitz, who built a protocomputer in 1939, describes the effect of the war on the development of real computers:

While the demand for rapid and inexpensive computation had been increasing for years before the war, the increase was, as we look back at it now, slow and insignificant in comparison to that which the war engendered. . . . New military devices, unsolved problems of tactics, unfamiliar
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subjects—they all demanded mathematical treatment if possible. (quoted by I. B. Cohen, 1988, p. 135)

What some people have called the first actual computer was built just as World War II was starting. It is almost unique among the early machines in that it was not paid for by the military. However, its designer, John Atanasoff did end up working for the U.S. Navy, and the working machines that came after his prototype were all built for the military (Loevinger, 1989). The point is not that computers would never have been developed without the military’s interest; after all they are an old dream. But they certainly would not have been invented so quickly, built so fast, nor designed in the ways they were without the sponsorship of the military.

Once the war was going in earnest the military put a tremendous effort into building more and better computers. William Rodgers notes in his history of IBM, Think, that the theory and technology to make the early computers, the ENIAC (Electronic Numerical Integrator and Computer) and the Mark I, was in place “twelve to fifteen years earlier” but there was not “the money or . . . incentive to do it” until the Army stepped in (1969, p. 189).

Actually the U.S. Navy and Army Air Force as well as the British military all played important roles in the birth of the computer. Probably the first real programs, and many other key aspects of modern computing, were developed by the British cryptanalysts, led by Alan Turing, with their Enigma machine. They played an important part in the Allied victory, but so did other computers—men and their machines.

Almost all the other founding fathers of cybernetics and computer science besides Turing were also doing war work. Norbert Wiener, who coined the term cybernetics, spent the war working at the MIT Radiation Labs. Vannevar Bush, an early experimenter on analog computers, played a major role managing military science as the head of the National Defense Research Committee. Claude Shannon did work on secrecy systems.

Wallace Eckert’s work for the Naval Observatory with IBM machines produced the first sequence-controlled calculator, which was used to generate navigational tables crucial in antisubmarine warfare. Prof. Howard Aiken built one of the world’s first computers, the Mark I, for the U.S. Navy at Harvard. His machine, and another at Bell Telephone Laboratories, were used to calculate trajectories of heavy artillery and anti-aircraft guns. The Mark I also calculated the design of lenses for reconnaissance photography and did applied mathematics dealing with magnetic mines. IBM built a number of Pluggable Sequence Relay Calculators for producing ballistic tables (Ceruzzi, 1989a, p. 13; I. B. Cohen, 1988, p. 131). There was also the computing work on the atomic bomb and ENIAC, the first electronic digital computer, which helped design the hydrogen bomb (Rogers, 1969, pp. 155–186). Although, as Paul Ceruzzi points out (p. 13) computers were not
crucial for making the first atomic bombs, the Mark I did calculations for John von Neumann on the problem of implosion (I. B. Cohen, pp. 131, 134). Computers did become central to the design and manufacture of all future nuclear weapons. The first problem ENIAC calculated was a physics equation for the atomic bomb laboratories at Los Alamos (Edwards, 1987, p. 51).

John von Neumann, considered with Turing, Wiener, and Shannon central to the creation of computing, spent most of the war at Los Alamos helping with atomic bomb calculations. It was there he also helped create game theory. But he did find time to consult on the Army project to build ENIAC at the University of Pennsylvania in Philadelphia (Heims, 1980, p. 181).

Radar, one of the truly decisive technologies of World War II, contributed many of the scientists and engineers who made computers possible, and at least one company—Raytheon. As Werner Buchholz remarked, “many computer projects started around a nucleus of wartime radar experts” (quoted in Ceruzzi, 1989b, p. 259).

Radar was part of the work on gun control that led to the founding of the Servomechanisms Laboratory at MIT to develop remote control systems, gun drives, radar, and similar machines. From that its work spread to analog and then digital computers. By the end of the war it was working on Whirlwind, a programmable flight trainer, for the Navy. This was a key beginning point for the postwar attempts by the military to apply computers and robotics to both war and industrial peace (Noble, 1986b, pp. 106–143).

Electromechanical analog computers predicted the shell trajectories for battleships’ 16-inch guns. They not only took into account the direction and elevation of the guns but also the rotation of the earth and the temperature of the propellant. Antiaircraft guns used “predictors” to aim, and bombers used cathode ray tubes to record when complexes of radar stations (called masters and slaves) put them over their targets, including the fire bombing of Hamburg (Crowther and Whiddington, 1948, pp. 51–55). The famous Norden bombsight includes a built-in calculator to gauge the influence of the plane’s speed, altitude, and drift.

Gun control led to what was probably the first attempt to develop an autonomous weapon, the automatic gun-laying turrets (AGLT), for Bomber Command. Freeman Dyson, who worked on this project, explains how the research engineers came up with a “magnificent solution” involving linking a “high-performance search-and-track radar and a gyroscopic gun sight . . . to a servosystem which aimed the turret and guns.” While the attacking fighter was still out of sight, the gunner could pull the trigger and destroy it. After a crash program the AGLT was produced and readied for operations, but it couldn’t be installed until every Allied aircraft had an automatic IFF (interrogation friend or foe) unit so the AGLT wouldn’t target friendly fliers and commit what the military calls fratricide. IFF accuracy had to exceed 99 percent if the weapon was to kill more enemies than friends. It never came
close. After much effort at the height of the war, the AGLT had to be abandoned. To this day the problem of fratricide and IFF has meant that the vast majority of air combats, including the most recent, have involved visual sightings, often at subsonic speeds, with machine guns or cannon being as important to combat success as missiles (Dyson, 1984, pp. 57–60).

The remote control of weapons, however, was advanced during the war. It started with a 1942 British project to use radar to guide bombers, termed "Bombing without Knowledge of Path, Place or Time" (Crowther and Whiddington, 1948, pp. 58–59). Germans had radio-guided bombs such as the HS-293 and the Fritz X, while the United States recycled old B-17s, filled them with 10 tons of explosives, named them Weary Willie's and sent them, radio-controlled by a manned B-24, with little effect against German submarine pens in the North Sea (Editors of Time-Life, 1988, pp. 62–63). These planes were referred to as "robots," "drones," and "missiles" by the Army Air Force, which was also working on an "orphan" version to be controlled from the ground with a range of 1,500 miles.9 There was also a plan to use crewless, explosive-laden boats controlled by aircraft beyond the range of vision. These Javaman boats, as the joint AAF-OSS project named them, would carry television cameras which the aircraft would monitor in order to guide them. They were approved for action against Japanese interisland railway tunnels, but the war ended before they could be tried.10

The Germans had more success with remote weapons. The HS-293 guided bomb and the SD-1400 gliding bomb were used to sink several ships, including the Italian battleship Roma while it was on its way to accept the Allied surrender terms. The Messerschmitt ME-163 rocket fighter, the FZG-76 (V1) pilotless flying bomb, and the A-4 (V-2) long range rocket all worked pretty well. Wernher von Braun also developed the beam-guided Wasserfall missile with a speed of 1,700 miles per hour and range of 16.5 miles, and Dr. Max Kramer invented the Ruhrstahl X-4, a 520-miles-per-hour air-to-air missile with a 3.4-mile range guided by two fine wires played out from the missile wings, and the X-7, a similar antitank missile (Macksey, 1986, pp. 158, 163, 168–169). When the war ended the Nazi scientists were working on an intercontinental rocket, the A-10, with a range of 3,500 miles. It would have been capable of hitting New York City and was scheduled for use in early 1946 (Sherry, 1987, p. 120).

It is a little known detail of technoscience history that two Germans, Konrad Zuse and Helmut Shreyer, almost invented the first computer. Zuse's first prototype was financed by Kurt Pannke, a manufacturer, but his later machines, and those of Shreyer, were paid for by the military directly or indirectly through the Aerodynamics Research Institute. Because of the war, which prevented funding of some projects and also resulted in the bombing of a number of prototypes, very few working machines were built. Still, Shreyer built the first electronic circuits and Zuse made several advanced calculators. The Z3 may have been the first programmable machine but it
was never put into real use because of memory limitations. The S1 took over 100 wing measurements for cheap unmanned flying bombs and calculated their future aerodynamic performance. When it was installed it replaced over 30 women "computers." The Z4 wasn't completed until the very end of the war. It was put into operation in Switzerland in 1950 and for several years was the only computer in Europe (Ceruzzi, 1983, pp. 21, 28, 38–39). The Germans had other mechanical computers as well, which they obviously felt were of supreme military importance, as the following strange incident at the end of the war in Europe revealed.

When the Third Reich fell U-234, a German submarine, surrendered itself at Portsmouth, N.H. Her mission, never fulfilled, was to deliver key technologies and information to Japan, Germany's main ally. Although the two Japanese officers on board killed themselves after writing a moving message of farewell to their German colleagues, the complete cargo and documents of U-234 were captured. Obviously, space on a submarine going half way around the globe was limited, so it is indicative of the growing importance of computers that a number of such machines, for both cryptography and fire-control calculations, were carefully stored on board along with various aircraft and missile blueprints, electronic circuits, and bars of platinum.¹¹

Despite Gen. Dwight D. Eisenhower's order that "There'll be no software in this man's Army!"¹² the postwar period was marked by an explosion in computer development, much of it paid for by the military. The military also facilitated a series of key conferences, such as the 1947 and 1949 meetings at Harvard, cosponsored by the Navy Bureau of Ordnance, and the 1947 and 1948 meetings at the Moore School, cosponsored by the Navy Office of Research and Inventions and the Army Ordnance Department. In the United Kingdom, the Ministry of Supply sponsored several key conferences as well, and the Post Office built a computer, MOSAIC (Ministry of Supply Automatic Integrator and Computer), for them as well (I. B. Cohen, 1988, pp. 123–124). Between them, the U.S. and British military paid for a huge proportion of early computer development.

The U.S. Navy's Special Devices Division, for example, which was started during the war to "exploit advances in electronics and other technologies," initiated a series of computer projects, Whirlwind, Cyclone, Typhoon, and Hurricane, each of which "simulated an aspect of air or space flight" (Ceruzzi, 1989a, p. 249). In the ten years from 1946 to 1955, the Office of Naval Research (ONR) cosponsored Whirlwind I at MIT, IAS (the Institute for Advanced Study), NAREC at George Washington University, and other hardware research at the National Bureau of Standards. They also paid for mathematical studies of fluid dynamics, plasticity theory, nonlinear control mechanisms, linear programming, game theory, decision theory, and inventory management. Just as important as this research, was ONR's regularly published "Surveys of Digital Computers" and the Digital Computer
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Newsletter. These publications were the first to network the computer industry/community together (I. B. Cohen, 1988, pp. 141-143).

In 1946 the airplane manufacturer Northrop, working for the U.S. Air Force, asked J. Presper Eckert and John Mauchly, coinventors of ENIAC (Electronic Numerical Integrator and Computer) to build the first compact computer, BINAC (Binary Integrator and Computer) to control the Snark, a jet-propelled, swept-wing, pilotless bomber. While they failed, the contract kept their company, Electronic Control Corporation alive and BINAC was the first operational computer in the United States to employ the stored-program principle. Northrop then hired Hewlett-Packard to build MADDIDA (Magnetic Drum Digital Differential Analyzer), which, although more reliable than BINAC, was also too large for the Snark, which ended up with an analog machine instead.

The Air Force also launched Project SCOOP (Scientific Computation of Optimum Problems), which funded George Dantzig while he invented the simplex method of linear programming to solve difficult logistical calculations. To run his programs the Air Force had the National Bureau of Standards build SEAC (Standards Eastern Automatic Computer), completed in 1950. But it really wasn't powerful enough for linear programming, so in 1952 the Air Force brought the second UNIVAC (Universal Automatic Computer) made by the Electronic Control Corp. (Ceruzzi, 1989a, pp. 24–25, 41).

The next year, 1953, the Air Force think tank, RAND, built its own computer, the JOHNNIAC, named after John von Neumann. That same year IBM began shipping its 701 computers, originally named the “Defense Calculator” (I. B. Cohen, 1988, p. 139). After installing the first 701 in their own world headquarters, IBM sold 701s to Los Alamos, Lockheed, the NSA, Douglas Aircraft, General Electric, Convair, the U.S. Navy, United Aircraft, North American Aviation, RAND, Boeing, another to Los Alamos, another to Douglas, another to the Navy, Livermore Labs, then General Motors, another to Lockheed, and finally, the nineteenth, for a joint military-Weather Bureau project (pp. 44, 46).

In the 1960s, massive computing projects continued. Most notably the SAGE air defense radar system of 52 linked Q-7 computers. It became operational in 1963. The system cost $8 billion dollars, which was a lot of money in the early 1960s (Ceruzzi, 1989a, p. 71). Aircraft, air defense, missiles, and nuclear weapons development continued to drive computer science as they had from the beginning. The Minuteman ICBM project, for example, “nurtured integrated-circuit production through its infancy in the early 1960s.” Even in 1965 Minuteman missiles still represented 20 percent of the integrated-circuit market. Ceruzzi concludes that the Minuteman II project played “a central role in bringing the chip to its present position in society” (1989a, p. 94).
The very first customers for Cray-1 supercomputers were the atomic energy organizations of the United States and the United Kingdom, which used them to design nuclear weapons. While veiled in secrecy, it is clear that the massive nuclear weapons industry has always been a major consumer of computers and a major producer of various innovations, especially in software.

Although it is equally shrouded in secrecy, there is also evidence that during this period the secret agencies, especially the National Security Agency, played a major role in the development of the computer. By 1990 the NSA had acres of computers at Fort Meade, Md. That was the result of years of effort, such as Project Lightning, implemented in 1957 by then NSA Director Bernard Canine, which aimed at increasing the speed of computers more than 1,000-fold in just five years. It was one of the few nonsecret NSA initiatives. After spending $25 million the NSA could claim a number of hardware improvements and partial credit for keeping several young computer firms alive. The NSA still stands high in the computer pecking order; it still usually buys one of the first production models of any new Cray or other supercomputer (Editors of Time-Life, 1988, pp. 46-47).

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Strategic bombing, systems analysis, and computers were the great military victors of World War II. It wasn't that they won the war, but they won the peace. They are reoccurring themes. Whether successful or not, the AI paradigm has continued to win converts within the military and outside it, in a reinforcing dynamic that shows no signs of slowing down. Indeed, these trends from the world wars have blossomed in the last 50 years into the system of postmodern war we now live with. They have become metarules in war's discourse system.

Seeing war as a discourse system, as well as a military reality, might help us understand why thousands of soldiers were sent to certain death against machine guns in World War I and why millions of civilians were bombed to death in World War II for no good reason whatsoever. In World War I the dominant discourse metarules insisted that attacking machine guns was the road to victory. Hundreds of thousands of deaths and several new technologies (tanks, gas) were produced before the faith in force of will was broken and faith in technology took its place. That faith in technology assured military technophiles that bombing cities would lead to victory, despite all the evidence to the contrary. The discourse metarules that justified strategic bombing are behind the current computerization of war that is the core of postmodern war. Through this discourse these metarules have determined the planning for postmodern wars, from the horrific imagining of World War III to the real horror of Vietnam.