

LETTER ON BLACKETT'S BOOK

Volta Torrey, former newspaperman and Nieman Fellow, writes that many of the reviewers of P. M. S. Blackett's book, "Fear, War, and the Bomb," seem to have hastened over one important feature in their anxiety to get at Blackett's conclusions. That feature is Blackett's use of the data from the United States Strategic Bombing Survey.

Torrey, at present managing editor of Popular Science magazine, was himself concerned with writing part of the bombing survey upon which Blackett draws so heavily. He feels that the Survey lends itself to conclusions quite different from Blackett's.

Discussions of military strategy are not normally within the scope of Physics Today, but physicists' ideas of how decisive the atom bomb may or may not be are given a great deal of prominence. It is to bring Torrey's contention to their notice that Physics Today publishes his letter in full.

Sir:

P. M. S. Blackett, the winner of the Nobel prize in physics in 1948, believes that thousands of atomic bombs would be needed to produce decisive results in a war with the Soviet Union; William L. Laurence, New York Times reporter whose articles about the bomb won a Pulitzer prize for him in 1946, believes that fifty bombs would suffice. This is an astonishing range. Blackett's estimate may be the result of more deliberate study than Laurence's, but the newspaperman's figure agrees better with the impressions given by most American physicists in their discussion of the effectiveness of the atomic bomb. Which estimate is closer to the truth? Assuming other factors to be about equal, what would be the order of magnitude of the number of bombs necessary to determine the outcome of a war between two great continental powers?

The question is grisly but morally important. The impasse in the United Nations over the American proposal for international control of fissionable fuel has increased the strain on relations between the United States and the Soviet Union. The physicists' concern about the military application of nuclear energy, and their warnings that no nation could develop atomic power plants without also increasing its potential military might, were important factors in the formulation of American foreign

policy. So some of the responsibility for the present deplorable state of world affairs may rest on the shoulders of the physicists.

If Laurence and other journalists, influenced no doubt by physicists to whom they have spoken, have led the American people and their government to exaggerate the importance of a nation's possession of the new weapon, the mistake should be rectified. The British physicist has undertaken this. If Blackett has erred, however, his fellow physicists certainly should warn those who sway public opinion and the officials who mold it into national policies against letting him mislead them—lest his mistake lead them to other and more serious errors.

Professor Blackett's book, "Fear, War, and the Bomb," has been widely reviewed. That his thinking seems to have been biased by admiration for the Soviet Union and suspicion of the United States has been noted. His disregard of qualitative differences in his attempt to equate the destructiveness of atomic bombs with that of other bombs has been challenged. And the reasonableness of his assumption that an increase in the tempo of a strategic campaign, which the development of the bomb has made feasible, would not greatly effect the results of such a campaign has been questioned. No further emphasis on these points may be needed here.

But Dr. Manuel S. Vallarta, the reviewer for *Physics Today* (March, 1949) credited Blackett with having made a "careful study" of the results of the bombing of Germany. And in the *Bulletin of the Atomic Scientists* Professor Philip Morrison has written that "Blackett's method is one of rational analysis," a method which Morrison considers "the most probable way to understanding." Since such remarks may well lead bystanders to place considerable credence in Blackett's quantitative analysis of the bomb's value, further consideration of his data and method might be advisable.

The Sample

Blackett summarized this portion of his work in this paragraph:

"We can safely assume that the number of atomic bombs required to produce decisive military results will increase with the area and population of the country under attack. Remembering that 1.3 mil-

lion tons of ordinary bombs were dropped on Germany during the second World War without decisive result, and assuming that some four hundred improved atomic bombs would be required to produce the same material destruction, it is certain that the number of atomic bombs required to produce decisive results in a war between America and Russia would run into thousands."

He chose the data regarding Germany, rather than figures compiled at Hiroshima and Nagasaki, because the strategic bombing campaign against Germany provided him with "a much larger and so more reliable 'sample' from which to predict the future." Most of the information about this sample which impressed him was published in the reports of the United States Strategic Bombing Survey (USSBS).

Its investigators found, in Blackett's phraseology, that "German total war production continued to increase 'till the summer of 1944 in spite of the very heavy bombing," and that "the rapid fall of production which started in August, 1944 . . . was due not to the destruction of factories or the demoralization of the civilian population, but mainly to the success of the air attack on the German transport system, which impeded the flow of coal, food, etc., and to the shortage of oil." So Blackett concluded that Germany's defeat "was certainly not due to the direct effect of bombing," but rather "was brought about primarily by her huge losses in manpower and materiel incurred in the land battles, particularly on the Eastern Front."

If this were a photograph made in a cloud chamber, its validity might be readily estimated by comparing it with other such pictures. But no other "experiment" in bombing was truly comparable to this one, and none which would be can be performed without another war, which everyone wants to avoid. Fortunately, however, other men's views of the same picture are known, and those views can be placed on an easel beside Blackett's. Some of the authors of the USSBS reports were as surprised as he was by their findings. But, after recovering from their amazement, they concluded their report on the war in Europe with a declaration that Allied air power had been decisive.

They explained this verdict, which was contrary to his, by pointing out among other things that air power "made possible the success of the invasion." The economy which sustained the German armed

forces, they continued, was brought "to virtual collapse" by the aerial attacks, "although the full effects of this collapse had not reached the enemy's front lines when they were over-run by Allied forces." And to those who challenge this view, they can cite many details from their report.

Nearly all of Germany's aviation gasoline was produced in hydrogenation plants. The first attacks on those plants were not made until May, 1944. The German Air Force's consumption of aviation gasoline, which reached a peak of 195,000 tons that month, fell to 182,000 tons the next month, 136,000 tons the month after that, and only 41,000 tons in November. At almost the same time that the strategic bombing of oil targets began, Allied airmen won control of the air, the training of German pilots was curtailed still more because of the fuel shortage, and the German Air Force never recovered from the deterioration in the quality of its personnel.

The oil shortage and mounting transportation problems hampered the movements of German panzer divisions with increasing seriousness in the summer after the spring in which the oil targets were first attacked heavily, and by December the shortage of fuel had reached "catastrophic proportions." In the war's final months, according to General Omar Bradley, "lack of gasoline in countless situations was the direct factor behind the destruction or surrender of vast quantities of tanks, guns, trucks, and of thousands upon thousands of enemy troops."

The great losses of men and materiel which Blackett calls decisive were heavier on the Eastern Front. But there, too, according to no less an au-

TEST BAKER AT BIKINI.

Ewing Galloway.



thority than Marshal Stalin, the bombardment of oil targets played an important part in the Russians' sweeping victories. At the Baranov bridgehead, the Germans massed 1,200 tanks to hold their line, but lost them because they ran out of gasoline. And a further result of the strategic attacks on oil was a reduction in nitrogen production, which became so serious that the powder put into German shells was diluted up to seventy percent with salt, which reduced the effectiveness of the ammunition.

The attacks on transportation targets also produced results which make one wonder about Blackett's assertion that bombing was not decisive in Germany. Aerial blows at four waterway targets "substantially eliminated" through traffic on the Rhine and North German Canals, says the USSBS, and by the close of 1944, air attacks on the railroad system "had reduced the available capacity for economic traffic in Germany to a point which could not hope to sustain, over any period of time, a high level of war production."

Though Blackett might say that results such as these were only indirectly or potentially decisive, rather than directly so, it seems reasonable to note that they could have been decisive if they had been obtained sooner, or if the Germans had not retreated so rapidly. And for speculative purposes such as he had in mind, would Blackett not have been wiser to seek a figure indicative of the tonnage of bombs which the USSBS reports indisputably show might have been ample to yield decisive results?

The Method

Having decided that 1.3 million tons were dropped on Germany "without decisive result," Blackett concluded that an equivalent number (four hundred) of atomic bombs would not have been enough. Using this as an abscissa, and the size and population of the country as an ordinate, he then projected a line indicating that more than five times four hundred atomic bombs would be needed to produce decisive results in a war with Russia.

Since this abscissa may have rested on a quibble, a reader of his book also may be forgiven, surely, for being curious about his ordinate. He finds it "useful to compare the areas and populations of Germany in 1939 and Russia and America in 1947." He does not include the areas and people of France, Italy, the Balkan countries and other parts of the world which were ruled from Berlin during part of

the strategic bombing campaign. Since the area and population controlled by Moscow at the time of any conceivable atomic bombardment may then be different than in 1947, however, this particular omission may not be unreasonable.

Let us consider, nevertheless, the safety of his assumption that "the number of atomic bombs required to produce decisive results will increase with the area and population of the country under attack." An elephant is many times as big as a mouse, and a more powerful bullet is needed to kill the elephant, but the elephant has only one brain and one heart. Hence, it can be killed by a single bullet. There is an analogy here to the structure of nations. They may differ greatly in size without necessarily having different numbers of nerve centers.

The production of many modern contrivances such as aviation gasoline and automotive vehicles often has been concentrated in large plants for reasons of efficiency. Even when production facilities are widely dispersed, the products usually must pass through transportation centers to be distributed promptly and economically to a large number of people strewn all over the map. And children can assure you that "for want of a horseshoe nail . . . a kingdom was lost."

The economy to which Communism has given birth may be utterly different. Conceivably, anyhow, it may be a series of independent, self-sufficient economies, rather than a unified, intricately interlaced structure such as was encountered in Germany. But Blackett's book offers us no evidence to this effect. If he had shown that the Soviet economy were not one but five or ten independent units, one might agree with him that it would be safe to assume that five or ten times as many bombs would be needed to produce results equivalent to those produced in Germany. But is it not dangerous to assume that a country's size and population is a sufficient index to the number of targets the bombers would have to find to wound its economy fatally?

It is true, of course, that bombing a distant target is more difficult than bombing a nearby one. But the range of bombers and the effectiveness of fighters are factors in the problem which are subject to change and it certainly should be easier to hit a distant target once with one bomb than to hit it many times with many bombs. As Blackett himself has noted, the permissible aiming error is greater when a more powerful bomb is used.

People Aren't Atoms

Blackett's method of deriving a quantity which he would like to know by an extrapolation based on known quantities—journalists have often been told—is one which has led to many important and useful additions to knowledge in physics. When this method of simple extrapolation is applied to human history, however, a danger lurks in it which Blackett appears to have overlooked. The particles with which a physicist deals in his laboratory may act the same way today that they did yesterday and will tomorrow, but the behavior of people cannot be predicted with an equally high degree of reliability. People may behave differently tomorrow because of what has happened to them today.

Blackett has apparently assumed that as many errors would be made in the application of destructive force from the air to Russia as were made in the bombing of Germany. Military errors often have been repeated. But fighters, like other craftsmen, may acquire skill by practice. And it is dangerous to assume that all of the lessons learned in Germany, about which targets to hit and how hard and when they should be hit to produce decisive results, have now been forgotten.

Laurence, the journalist, chose the approach used by American physicists in estimating the decisiveness of the atom bomb in war. He looked for suitable targets and counted them. He found forty cities, each of which has a population of more than two hundred thousand. He then allotted a bomb to each of them and added ten to allow for the larger cities and the oil fields of the Caucasus.

If Laurence was thinking—as Blackett believes many Americans have thought—of the bomb primarily as a weapon of mass destruction, he may have

erred. But if Laurence also had results other than mass destruction in mind, as his mention of the oil fields may indicate, it could be that his guess was a good one.

Turning to Blackett's sample again, one finds a great many facts tending to suggest that the prompt destruction of a fairly small number of targets would have sufficed to defeat Germany, if as much had been known then about the German economy as is known now. Ten hydrogenation plants, for example, produced eighty percent of Germany's aviation gasoline. One set of Schweinfurt plants account for fifty-two percent of Germany's production of anti-friction bearings. Even electric generating facilities were concentrated enough so that a few bombs directed at them might have had very significant results.

But such data regarding the German war machine may have no relevance to the situation in the Soviet Union. If it is necessary to peer through censorship and tell people how many atomic bombs would be needed to win a war, it might better be done by those who know most about the economic structure of nations.

Is it not the duty of physicists, however, to recognize the limitations of their methods? Should they permit a scientist's achievements in one field to blind them to his errors in another? Should they stand idly by while propagandists employ the prestige of one of their colleagues to lead nations astray?

It often has been said that, regardless of the bomb's effectiveness in war, it awakened its makers to their responsibilities as citizens. Pardon me for asking, but are physicists dozing again?

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