# SCIENCE

VOL. 102 FRIDAY, NOVEMBER 2, 1945 No. 2653



SCIENCE: A Weekly Journal, since 1900 the official organ of the American Association for the Advancement of Science. Published by the American Association for the Advancement of Science every Friday at Lancaster, Pennsylvania.

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Annual subscription, $6.00 Single copies, 15 cents

# THE ATOM AND HUMANITY[1]

By Professor **HAROLD C. UREY**

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ALFRED NOBEL, whose birthday we celebrate to-day, was the inventor of dynamite and of smokeless propellant powders. At the same time that he engaged in this scientific research he was very much interested in bringing lasting peace to the world. In a conversation with his friends he remarked that his explosives would bring peace more quickly than peace societies. After some fifty years we now realize that Nobel was wrong in his conclusion, and we find that the peace societies were also unsuccessful.

To-day we are faced with far more powerful explosives than any that Nobel dreamed of, and we are still discussing wars and means of bringing peace to this planet. It is my purpose to discuss the relationship of this newest weapon, the atomic bomb, to the problem of world peace. May I say that this discussion has no relationship to any atomic bomb legislation or any diplomatic moves of the United States Government. It is intended to bring the urgency of the problem before you and to discuss some long-time views relative to enduring peace.

First of all I wish to show that the progress of every weapon that has been invented by man proceeds through the stages of crude invention to successful improvements, and the development of counter measures against it. The position of weapons of this kind as we know them to-day, is that they are in use by major combatants; that they produce a great deal of destruction in modern war, and that no completely decisive defense against them has ever been secured.

[1] Address delivered at the luncheon commemorating the birthday of Alfred Nobel, on October 21, 1945.

Only when a weapon is completely superseded by a more effective one does it disappear from war. Following this line of argument we may expect that our atomic bombs will be obsolete only when more terrible weapons have been developed.

Machine guns were invented in the seventeenth century. They were relatively ineffective until the first world war, when they were firing 600 or 700 rounds per minute, and accounted for many casualties. During the second world war machine guns of many varieties were mounted on planes, tanks, ships and other mobile mounts. Fighter planes carried as many as eight machine guns, and the large bombers were fully armed to take care of attack from any direction. The principle has been applied to larger caliber weapons, and these have had automatic aiming devices of great efficiency attached to them. No decisive counter defense against the machine gun has been found, and there is no indication that any government in the world thinks that it does not need machine guns in modern war.

A submarine sunk the *Housatonic* at Charleston during our Civil War. Submarines were steadily improved. In the 1890's they had reached a size of about 200 tons. In the first world war they began with 600–800 tons and rose in size to about 2,000 tons. In this last world war they very nearly won the battle of the Atlantic. Many counter measures against the submarines were devised, and were found to be more expensive than the submarines which they fought. We won the battle of the Atlantic, and the submarine was temporarily out. At the present time the talk is of larger submarines, and it is believed that they can be built.

The airplane was developed in the first years of this century. During the first world war it was used for scouting, and before the end of the war carried a machine gun. At the beginning of World War II the plane had evolved into the complicated machine of metal with engines of high power using high-grade gasolines as fuels and carrying many machine guns and modern size bombs. Before the end of the war they evolved into enormous machines carrying many tons of bombs and machine guns to defend them. They finally were powered with jet-propelled engines and carried rockets to attack other airplanes and other objectives.

They destroyed the cities of Germany and Japan and damaged cities of England, Russia, China and Poland. No decisive defense against the airplane is known. Many intercepting devices have been developed, and they do prevent the plane from exerting its full effect. Only superior air power was effective. Each combatant threw in every ounce of effort to manufacture more and better planes, bigger and more numerous bombs and more clever mechanisms to guide them and to detect them. And the victory came to the combatant with the greater industrial capacity.

This victory came only after all combatants, with the exception of the United States, had been very seriously damaged by this weapon of modern war. In the future we may expect larger and faster military planes, and all cities of the world can be expected to crumble under the loads of ordinary bombs which such planes will carry. Some will be intercepted, but some will get through any defenses that we are likely to devise.

I could repeat this story with tanks, plane carriers, high caliber guns and many other weapons great and small. Any abolition of a weapon is due to the invention of something still more effective in destructive power.

We might further mention some new weapons which were developed in this war. The V-1 or the so-called buzz bomb caused some damage, but was rather easily intercepted because of its low speed. The V-2 was in a very different category. At the beginning of the war rockets were essentially toys, but at the end of the war this rocket traveled 200 miles and rose nearly 100 miles above the earth and arrived at a velocity above that of sound so that it could not be heard before it arrived. It seems that this weapon can be further improved and probably can be aimed from still greater distances and guided by radio. It can be expected that it will follow the same course as others which we know.

Finally there is the most spectacular weapon of all —namely, the atomic bomb. This weapon stopped the war and probably saved the lives of many allied soldiers. It also presents the people of the world with a most momentous problem. Briefly, it destroyed two cities of Japan. Four square miles of Hiroshima were utterly destroyed, and the area of devastation in the case of Nagasaki was even greater —approximately 10 square miles. The total area of the city was not destroyed because of its narrow shape. The energy liberated was approximately equivalent to that released in the explosion of 20,000 tons of TNT. These two bombs were the second and third of this type to be exploded, and the third one was definitely an improvement on the second.

In regard to the future development of this weapon, we can confidently expect that it will follow the course of other military weapons which I have discussed briefly above. We can hardly think that the atomic bomb is as primitive as the early machine guns, submarines and airplanes, at this stage, but that great improvements are possible seems a certainty. One can be quite sure that the ingenuity of man will make possible the manufacture of such bombs on a large scale.

Due to secrecy maintained in the development of

this bomb, the attacks on the Japanese cities came as a complete surprise to the enemy. A single plane carried each bomb over its target. No attempt at interception by the enemy was encountered, so that bombing conditions were favorable as compared with what they would have been had the enemy expected such an attack.

The light construction of Japanese cities undoubtedly contributed to the vast destruction effected. It is hardly to be expected that steel structures would crumble so easily, though photographs of some of the industrial plants showed masses of twisted steel in the burned-out plants. In a modern city the destruction might not be so complete, but there is no doubt that the destruction would be vast and would probably set fires which would completely destroy modern buildings.

This weapon at its initial trial represents an advance over existing weapons beyond that secured by any other weapon ever devised, and considering the sort of weapons already mentioned this is indeed a remarkable statement. This weapon poses one of the most serious problems ever faced in the history of man, and beside it other problems fade into insignificance. I am amazed that any one can take our present-day strikes, reconversion, transporting the soldiers home from abroad and other current problems very seriously. They will all be solved some way, and their solution, whatever it may be, will not affect any of us very greatly. But atomic bombs are a different matter entirely.

Let us consider the problem of a war of atomic bombs. X years from now we shall have a stock pile of these weapons and will have unprecedented power in our hands. If only no other countries have them we shall feel very safe and secure. Of course, the citizens of any other country in the world will feel the same way. Thus the British will feel safe if Britain has these bombs and no other country has them; the Russians will feel safe if they have them and no other country does, and so with the people of other countries, but if all the countries of the world have them none of us will feel safe; on the contrary, we shall live in constant fear of sudden and violent death. A world of vast fear and apprehension will be our lot and that of our children. Whereas Hitler thought he could win his war in months, these weapons will encourage future aggressors to attempt the conquest of the world in a few days.

I have already mentioned what we may expect in regard to the future development of bombs based upon the past experience with military weapons. It is unnecessary for me or you to have any special information in regard to future plans for atomic bombs to draw this conclusion. But even if no improvement in the bomb were possible, what we have learned from the newspaper accounts of the bombs already exploded, shows that they are bad enough. If one bomb will devastate an area of 10 square miles 1,000 bombs of this kind if properly placed would devastate 1,000 square miles. The area of New York City covers a densely populated area of about 300 square miles. From this it is easy to calculate that these 1,000 bombs if properly placed would destroy thirty-three cities of the size of New York.

And what is there to prevent our assuming that with sufficient effort 10,000 bombs can not be secured? It is wrong to assume that these weapons can not be made in large numbers as a result of future improvements in known processes.

During World War I, a strip of country across northern France and Belgium was laid waste. In World War II the cities of Germany and Japan were almost totally destroyed, as were some of those of Russia and Poland. Extensive damage was done to the cities of England. Without considering the contribution that atomic bombs may make to the destruction of cities in future wars, is it not reasonable to expect that much more damage will be done in World War III? Is it not probable that the cities in the United States would also suffer?

If atomic bombs are used in the next war it seems certain that all the principal cities of the world, including those of the United States, will be utterly destroyed and their inhabitants killed. Perhaps some will disagree with this statement, but perhaps we can settle on half of them being destroyed, or a third, but does this make any difference in our considerations. Let us accept the fact that an atomic bomb war is bound to be much more destructive than this last war; that it is bound to extend to all the industrial countries of the world.

We can expect that counter measures will be devised, just as they have been in other cases. Some of these counter measures will interfere with the delivery of the bombs. We can also expect that counter measures to the counter measures will be developed, and more effective methods for the delivery of bombs will be devised. It may be possible to interfere with the delivery of the bombs, but then some new device will be found by some one which will then make their delivery possible. What I wish to say is that we can not expect that a defense so effective that either the United States or any other country will decide that it is useless to manufacture such bombs will be devised. It will again be the case of dog eat dog, and much effective indiscriminate biting will result in the process. Let us then set aside the assumption that a decisive defense will be secured. Such an assumption would be contrary to experience and would be the most foolish of wishful thinking.

But we may ask whether other countries will get

these weapons. It seems unnecessary to answer this question. What weapon ever devised by man ever remained the possession of the country of origin? Did this apply to machine guns or submarines or planes or tanks or high explosives or gas or guns of any kind? We may rest assured that other countries can secure atomic bombs and may secure them more quickly than we think.

Many people ask how long may it take other countries to secure these bombs, and various estimates have been made. General Leslie R. Groves has estimated that this will be from 5–10 years. It took us 3½ years from the start of serious efforts to the time when the first bomb was exploded. Further time is needed for production of an adequate supply for a really full-scale war. We should note that the British start with nearly full knowledge of our processes, and the whole world knows our lines of attack on the problem, and that these lines led to success. This is a very great advantage. Other countries at the present time must be very much afraid of the United States, in spite of the fact that aggressive war or any kind of war is far from the minds of the people of this country. The scientists, engineers and citizens of other countries will feel that their respective countries are in dire peril.

Just imagine our sense of fear were some other country in possession of atomic bomb plants and we were not. This sense of emergency will call forth the greatest effort on the part of other countries, and I think the lowest figure given by General Groves is the safer one for these considerations. Let us then assume that we have five years in which no other country could attack us with atomic bombs.

What shall we do under this threat in this brief respite? This is a very difficult question because the problem is a very complex one. Incidentally, the problem is not made different nor more complex by the atomic bomb, for the destruction that could be made without its aid would also present a very serious problem to the world. The atomic bomb really accentuates the difficulty, and perhaps is of real value to us in bringing forcibly to our attention the grave problem ahead of us, and it may induce us to make concessions from our established ways of thinking which are necessary if destruction by this means is to be avoided.

In a democracy it is necessary to have an informed people if proper decisions are to be made and executed. We must all understand that the most devastating weapon of all times is now in our hands and will soon be in the hands of other industrialized countries. We should face the facts and not engage in wishful thinking, for wishing will never remove the threat of this bomb. We should rise to our responsibilities and not merely put the matter aside because we wish so much to get back to our peace-time pursuits.

We can not pass this on to the Congress or to the President, for they can not act effectively without the approval of the people of the United States. Also, they should not move contrary to the wishes of the citizens of this country. We must first understand the magnitude of this problem and then must be prepared to act with courage.

Let us consider some possible ways of controlling the atomic bomb. In the first place, many people suggest that we should make ourselves stronger than all other nations. This is implied in all the discussion of keeping the so-called "secret" of the bomb. In my opinion if we published all our data in detail we would not shorten the five or ten years of General Groves's estimate by very much. It takes time to build plants, and it takes time to operate them.

The whole question of the atomic bomb secret is not important in itself. What is important is the policy back of it. Do we intend to engage in an armament race with other countries of the world? If the answer is yes, we should try to inspire all our people to go to work on this problem in order to produce the greatest number of the biggest bombs that can be devised, and to devise the most effective way of delivering them to those enemies of the United States that we intend to attack or that we fear will attack us. This policy will result in an atomic bomb war with all the destruction that I have tried to emphasize in this talk, and this is exactly what I should like to see avoided.

We may try to outlaw the atomic bombs in the future. Some people say that poison gas was not used in this war because of such agreements between sovereign nations. That is only a partial truth. It is certainly a question as to whether high explosive and incendiary bombs are not more effective, ton for ton, than is poison gas, for the former not only kill people but destroy cities, while the latter leaves the cities intact.

If atomic bombs are in the possession of potential enemies of the United States we shall all be afraid that they will be launched against us by means of rockets, pilotless planes or something else, and without warning. We must watch our borders for all stray planes that might be coming in. We must introduce a police system that will be able to detect any possible planting of these bombs in our cities where a mere alarm clock would set them off at a predetermined time. The fear and tension under which we will live will make us very nervous indeed. Every country of the world will have an itchy trigger finger if we all have the atomic bombs and merely an agreement not to use them.

I do not trust any such way of controlling the use

of atomic bombs. If the nations agree not to use them and are sincere, then they should also agree not to make them. Incidentally, the Pope tried to outlaw the cross-bow in the twelfth century and from that time to this no outlawing of weapons between sovereign states has been effective.

The suggestion is made that we turn the bombs over to the United Nations organization to enforce peace. This suggestion is better, but it also has difficulties. Where would we store the bombs in the possession of the United Nations? Europe and Asia would object to North America, and we would object to Asia or Europe. How about Africa? You can imagine that the United Nations would have an effective small policing army powered with atomic bombs at some isolated point. Would we not all be afraid of the United Nations organization? Would we not fear that some Hitler might gain control of those weapons and subjugate the world in a very short time?

There is another difficulty. We presume that if the United Nations has a store of such bombs, it proposes to use them in emergencies. Let us assume that manufacturing the bombs in any country is a criminal offense, but that in spite of this the administration of the United States decides that it will make these bombs. The United Nations can then use the bombs to interfere with this operation. They will use them to destroy all the manufacturing facilities that might be set up. In so doing they will kill a very large number of quite innocent people, and the effect will be to unite the entire country against the United Nations.

If one wishes to police any state or nation, or the world, one wants to use weapons for the police purpose that will distinguish between those who violate a law and those who do not. If one can do this the law-abiding citizens will aid you against the law breaker, but the use of a large weapon of necessity unites all classes against the policing power. Atomic bombs are good for nothing but wars and for the destruction of large cities and their populations and large industrial plants.

But this proposal to turn the bombs over to the United Nations leads to a further suggestion. If we turn over the most powerful weapon to the United Nations why not also turn over all large caliber weapons of all other kinds for, of course, they are relatively ineffective against a superior weapon. And then we come to the next step. If we have turned all our large caliber weapons over to the United Nations, it is unnecessary for this organization to have them either, for there is no one to oppose them.

We are inevitably led to the conclusion that a superior world government of some kind possessing adequate power to maintain the peace and with the various divisions of the world relatively disarmed, is the only way out. What will be needed is a most efficient inspection service which will detect and report promptly any attempt to produce atomic bombs or other heavy arms and a sufficient police force to prevent such activities. In this way neither the countries of the world nor the United Nations organization will have atomic bombs and no one will need to fear them.

I am not so naive as to think that this is a solution easily arrived at. I am not even so sanguine as to think that there is a high probability that logical action of this kind can be accomplished without the dubious advantage of a third world war. But I pass the problem to you now. Do you see any way to avoid the threat of an atomic war?

I think I have said enough to give my audience an opportunity to think these things over. I trust the conclusions of an informed populace of the United States. I believe that the considered judgment of the whole people is a reliable guide, and, after all, it is the people of the United States who face destruction and death, and they should have the privilege of making their own decisions.

There are a number of statements which I would categorically defend, and I wish to present them to you:

(1) If atomic bombs are made in one country they will be made in all industrial countries of the world.

(2) If atomic bombs are made in all these countries we will spend all our days in deadly fear that they will be used, and in time they undoubtedly will be.

(3) By one means or another no atomic bombs must be made anywhere in the world and they must not be in the possession of any government of any kind.

(4) The peace-time applications of atomic energy, or, in fact, of anything else, are of no importance whatever unless the danger of atomic bombs is banished from the earth.

In conclusion, may I repeat the hope of Alfred Nobel, that this weapon is sufficiently terrible to make possible the bringing of peace to the earth.

# OBITUARY

## ACADEMICIAN V. I. VERNADSKY
### 1863–1945

THE news came from Moscow of the death on January 6, 1945, of Professor V. I. Vernadsky (see SCIENCE, 101: 110, 1945). With his passing Russia lost one of its oldest and most distinguished scientists of international renown.

Vladimir Ivanovich Vernadsky was born on March