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Scientific Knowledge, Ethics and Moral Responsibility

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Abstract

Despite the many benefits and blessings that were made possible by the advancement of science, the grave consequences of the advancement of scientific knowledge cannot be overlooked, including for example the pollution of the earth and its atmosphere, centralisation and the diminished role of individuals and the uniformity and the disappearance of local cultures. The dilemmas that face scientists are threefold: the dependence of scientists and scientific research on men of power, free enquiry and academic freedom and sharing and publication of scientific information.

Science: A Blessing or a Curse?

Has science been a blessing to mankind? Or has it been a curse? Many thinkers and scientists believe this to be an open question.

It is quite normal for scientists when speaking about science and scientific inventions to talk as if science had been a blessing to mankind. One has only to think of the many benefits and blessings that were made possible by the advancement of science: airplanes, cars, telephones, electricity, to name a few, and now computers and IT. Science has made it possible for people to live longer, healthier lives and have more leisure and pleasure. Plagues that used to wreak havoc in men's lives and kill thousands and hundreds of thousands of people are now a thing of the past. Thanks to science, people all over the world live now in one happy world that has shrunk and continues to shrink, where ideas are instantly communicated and exchanged and commodities transported across the globe, where it is no longer possible for people or communities to live in isolation. The world has become one big happy family. Was there a price to pay for all this achievement? Naturally! But what a small price to pay for such huge achievements! Science has indeed brought about pollution of the earth; it has brought nuclear and other weapons of mass destruction. But these and similar issues can and will soon be dealt with and controlled by science. Or so say the advocates of science.

In their enthusiasm for the blessings of science, its advocates tend to overrate its achievements. Science, to take an obvious example, has indeed improved human life and made it longer and safer, but it has not eliminated disease and pain. "Medicine, as Dr. Alexis Carrel says, is far from having decreased sufferings as much as it endeavors to make us believe. Diseases have not been mastered. They have simply changed in nature. Indeed, the number of deaths from infectious diseases has greatly diminished. But we must still die, and we die in a much larger proportion from degenerative diseases… chronic affections, (especially) cancer, diabetes, and heart disease, the diseases resulting from civilization. This change… may be due to modifications in the constitutions of tissues under the influence of the new modes of life. The organism seems to have become more susceptible to degenerative diseases. It is continually subjected to nervous and mental shocks, to toxic substances manufactured by disturbed organs. (Man) is equally subject to the organic and functional disorders brought in their train by excess of food, insufficient physical exercise, and overwork."

Grave Consequences

Furthermore, scientific advances and discoveries have in general been made without any regard or consideration of their long-term consequences, and some of these consequences are too serious and grave to be ignored or glossed over, no matter what advocates of science may say. The most serious and obvious of such grave consequences of the advancement of scientific knowledge include among others:

1. Pollution of the earth and its atmosphere, and the possible upsetting of the natural balance and equilibrium, the consequences of which may not be fully known for some time to come.
2. The development of weapons of mass destruction.
3. The promotion of the power of dominant groups and all that it entails including centralization and the diminished role of individuals, uniformity and the disappearance of local cultures, the emotional and mental control and manipulation of people and the possible establishment (in the not too distant future?) of unthinkable horrors such as people farms, where people may be bred for their organs in order to have a ready supply of them for men in power (Fig. 1).

Figure 1: Ready supply of human organs.

The problems of pollution and related issues and also those of nuclear and other weapons of mass destruction are all too familiar to warrant exposition here, but something must be said about the equally serious, though seldom addressed, issue of the promotion of the power of dominant groups and leaders.

Centralization and the Diminished Role of Individuals

The fact that the advancement of scientific knowledge and inventions and the subsequent mechanization of life have increased the power of dominant groups and governments is often ignored and not given sufficient recognition as compared to the other grave consequences of pollution and weapons of mass destruction. With the state assuming ever greater power over the lives of men, individual liberties have been severely curtailed. The direct result of such power increase has been an ever-increasing centralization and control from a center, which has been made relatively easy by modern means of communications and other scientific inventions. Needless to say, that without such means and inventions control from a center would have been very difficult. State power and centralization made the individual man almost entirely helpless. Thanks to science, it is no longer possible for any individual not supported by a dominant group, to make a difference in the world.

As Bertrand Russell (Fig. 2) says: "In ancient empires, provinces were governed by practically independent satraps or proconsuls, who were appointed by the central government, but decided almost all questions on their own initiative. What applied in politics applied also in business: an organization controlled from the centre had to be very loosely knit, and to allow much autonomy to subordinates.

"Now-a-days all this is changed. Telegraph, telephone, and wireless make it easy to transmit orders from a centre: railways and steamers make it easy to transport troops in case the orders are disobeyed."

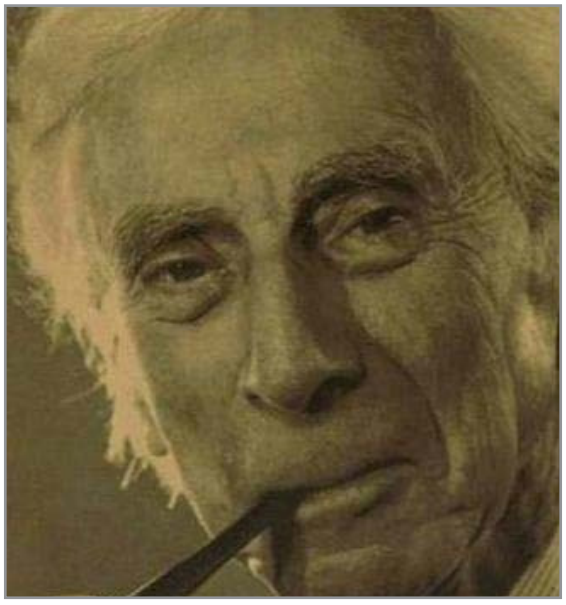


Figure 2: Bertrand Russell

Science and scientific inventions have also given dominant groups and communities more power, and governments have become more powerful and more organized.

Furthermore, science has increased the effect of dictators and leaders on followers, and the control of events by a few prominent personalities has become more marked. Miguel Angel Asturias's The President and George Orwell's Nineteen eighty-four are just two examples of the power that science has made it possible for dictators and despots to wield over helpless individuals (Fig. 3). Furthermore, such despots and dictators are often eulogized and idolized in a way that make them not much less than divine or demigods. In fact, in some nations, such dictators and despots are given all the attributes of God the Almighty himself in wisdom, knowledge, ability, mercy, power and greatness. George Orwell's Big Brother with his telescreens and Thought Police is no mere fiction, but has already become an ugly reality in many a nation. The individual as described in his Nineteen eighty-four has absolutely no control on the events of his life, and anyone, even an Inner Party member, may vanish and be vaporized and cease to exist, or in short become, in the Newspeak jargon, an unperson that has never existed, all records or evidence of his existence being destroyed.

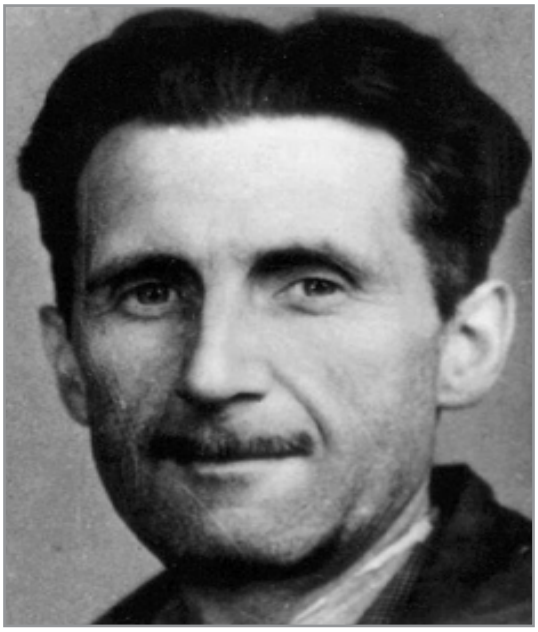


Figure 3: George Orwell

The increased power of leaders, despots and dictators afforded by the advancement of science did not, however, go hand in hand with their wisdom and ability. In the words of Dr. Alexis Carrel, "modern civilization, despite the immense hopes which humanity has placed in it, has failed in developing men of sufficient intelligence and audacity to guide it along the dangerous road on which it is stumbling. Modern civilization seems to be incapable of producing people endowed with imagination, intelligence, and courage. In practically every country there is a decrease in the intellectual and moral caliber of those who carry the responsibility of public affairs. It is chiefly the intellectual and moral deficiencies of the political leaders, and their ignorance, which endanger modern nations" [1].

To Quote Bertrand Russell again

"It would seem probable that, in the next fifty years or so, we shall see a still further increase in the power of governments. The forms of democracy may survive if those who possess military and economic power can control education and the press, and therefore can usually secure a subservient democracy."

Summarizing the Overall Effect of Science in this Regard, Bertrand Russell goes on to say

"Science enables the holders of power to realize their purposes more fully than they could otherwise do. In the present age, it seems that the purposes of the holders of power are in the main evil, in the sense that they involve a diminution, in the world at large, of the thing's men are agreed in thinking good. Therefore, at present, science does harm by increasing the power of rulers.

"It (Science) has given communities more power to indulge their collective passions, but by making society more organic, it has diminished the part played by private passions. Men's collective passions are mainly evil; far the strongest of them are hatred and rivalry directed towards other groups."

In the George Orwell's super state of Oceania (roughly the Anglo-Saxon world), hate directed at real or imaginary enemies is an indispensable element of national life and politics, for which not only the daily Two Minutes Hate were assigned but also the all-important annual Hate Week.

Uniformity and the Disappearance of Local Cultures

Science has also led to uniformity. More and more people all over the world are becoming similar in their habits, the food they eat, the clothes they wear, the books they read and the TV programmes they watch. Variety and local cultures and peculiarities are fast disappearing. Some might argue that this would lessen conflicts and lead to better human understanding and dialogue. World events in the past few decades do not warrant such a belief.

Uniformity of News

The uniformity of news is another aspect of the uniformity that scientific inventions have made possible. It is rather ironic that with the overwhelming multiplicity and increase of TV satellite channels available nowadays, the real choices have become much less, for it seems that all these different channels are speaking with one voice. At home I had once an idea of organizing my news channels consecutively, so that I can go through them quickly and compare their news and views. To my utter surprise I found that the international news broadcast and the views expressed by almost all channels not only were they the same, but they were presented in almost exactly the same order by almost exactly the same words, and one can easily follow the same bit of news while flicking through the channels broadcasting in different languages.

Uniformity of Education

And what applies to news applies equally to education, for education has become more uniform and is likely to become even more so. Uniformity may have its advantages in terms of facilitating mobility of students and teachers, or insuring quality and higher standards, but its drawbacks must not be overlooked. Uniformity of education may run counter to the pursuit of originality and creativity. Graduates produced according to a set standard, imitating the similarity of machines, are not likely to be forerunners of advancement and invention.

In the education of his own children, the individual man has become powerless, depending on the uniform education provided by the state, in a world where state education has become one and the same all over the world, any deviation therefrom or difference being often deemed dangerous or subversive or worse.

Emotional and Mental Control and Manipulation of People

It may not be long now before science can make it possible for people in power to control the emotions, feelings and thoughts of people both individually and collectively and not just by means of propaganda or education. In George Orwell's Nineteen eighty-four, Winston Smith was made by means of physical and psychological torture to believe whatever he was told to believe, even to the point of accepting that two and two make five. In the words of the future grand inquisitor O'Brien: "the (old) Inquisition was a failure … because (it) killed its enemies in the open, and killed them while they were still unrepentant: in fact, it killed them because they were unrepentant [2]. Men were dying because they would not abandon their true beliefs. Naturally all the glory belonged to the victim and all the shame to the Inquisitor who burned him … the heretic walked to the stake still a heretic, proclaiming his heresy, exulting in it. Later, in the twentieth century, there were the totalitarians, as they were called. There were the German Nazis and the Russian Communists. The Russians persecuted heresy more cruelly than the Inquisition had done. (Again) the victim of the Russian purges could carry rebellion locked up in his skull as he walked down the passage waiting for the bullet. But we make the brain perfect before we blow it out. We do not destroy the heretic because he resists us: so long as he resists us we never destroy him. We convert him, we capture his inner mind, we reshape him … we bring him over to our side, not in appearance, but genuinely, heart and soul. We make him one of ourselves before we kill him."

Thanks to the advancement of science, reshaping people, converting them to your way of thinking and capturing their inner minds may soon be possible if not already so.

Bertrand Russell says: "(Science) will in time find ways of controlling emotion, which it is scarcely possible to doubt. When that day comes we shall have the emotions desired by our rulers, and the chief busine ss of elementary education will be to produce the desired disposition, no longer by punishment or moral precept, but by the far surer method of injection or diet. The men who will administer this system will have a power beyond the dreams of the Jesuits, but there is no reason to suppose that they will have more sense than the men who control education to-day. Technical scientific knowledge does not make men sensible in their aims, and administrators in the future, will be presumably no less stupid and no less prejudiced than they are at present."

Possible Establishment of Unthinkable Horrors

People may soon be bred in farms for their organs as spare parts for the powerful. Has this already started?

Ethical Responsibility

Should scientists be held morally responsible for the grave consequences of their inventions and discoveries? Or should the ultimate responsibility for any abuse of scientific knowledge lie with the people who have the means to allow or restrict such abuse, and scientists should in no way be held responsible for the abuse that other people may make of their inventions and discoveries?

The dilemmas that face scientists are threefold:

1. The dependence of scientists and scientific research on men of power

Can scientists afford to think of ethical considerations and forego the patronage and support of men of power? Who would support them in their work if they choose to free themselves of the patronage of men in power?

It is a tragic fact that men of science have always worked in the service of men of power. Men of science may be driven in their work by their love of science and scientific enquiry only to find in the end that they have been doing the bidding of their masters and benefactors (Fig. 4).

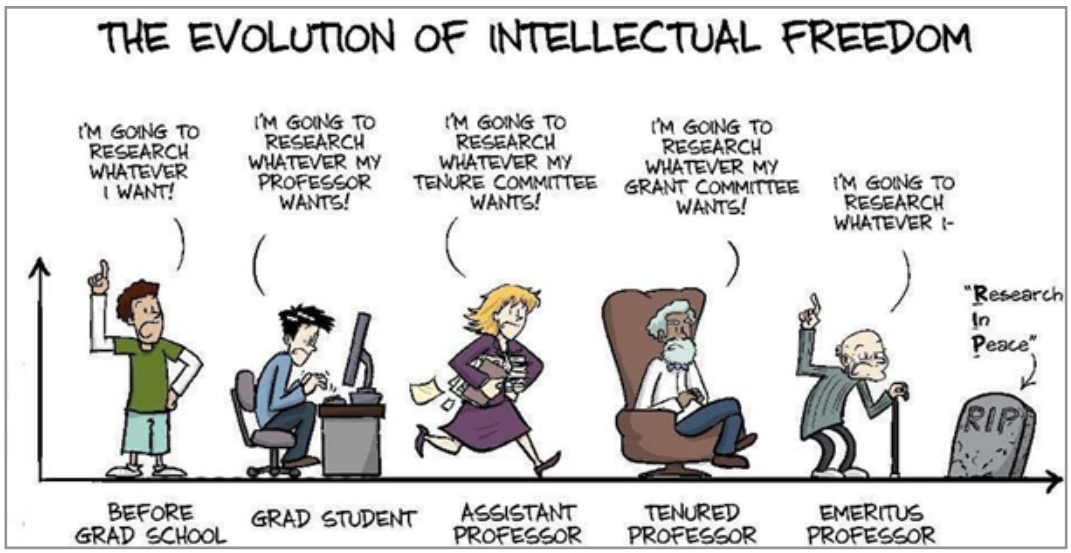


Figure 4: Evolution of intellectual freedom.

Their dedication to science and scientific enquiry and their need for material and political support often make scientists acquiesce to being manipulated and exploited by men of power to the extent that scientists become in the end mere servants or tools in the hands of men of power who alone can direct scientific research and make it possible and who can use or abuse its findings.

Most scientists are prone to the common fallacy of believing or pretending to believe that their inventions and discoveries would be utilized as they would wish, which is of course a delusion. An invention or a discovery once made by men of science is taken over by men in power and scientists are almost always left out.

The truth of this is nowhere borne out more strikingly than in the history of the first atomic bomb. The scientists who worked in developing the atomic bomb believed that the American government would treat the discovery with respect and would resist actually using the bomb. They failed to foresee that America's atomic research would be managed by the military and not by the scientists involved in that research. When it was found that Germany had no bomb, someone said, 'That's wonderful; we won't have to use ours'. A US army officer retorted, 'Of course you understand that if we have such a weapon we are going to use it'. And they did.

2. Sharing and publication of scientific information.
Can scientists afford to withhold discoveries that might be abused by people in power?
Withholding discoveries once they have been made runs counter to the principle that scientific information should be shared. Scientists, like other people in other walks of life, need also the recognition and esteem of their fellow workers and the public at large for their work and discoveries. The Hungarian physicist Leo Szilard, who was afraid that Germany might try to make an atomic bomb, tried to stop publication of the news that atomic fission was possible, but in the end this information was released.

3. Free enquiry and academic freedom
Can scientists afford to think of ethical considerations and possible consequences of their discoveries when such thoughts and considerations are bound to restrict academic freedom and imprison if not stifle the spirit of scientific enquiry.

It is science and scientific knowledge and endeavour that make man unique. Seeking knowledge and conducting scientific research is what characterises human beings and separates them from the dumb animals, and academic freedom is a necessary or an essential condition of it.

Science advocates argue that research and the quest for knowledge cannot be restricted or stopped by ethical considerations. Scientists should continue to do research and work to advance human knowledge regardless of the consequences of their research findings. It is up to the society at large or its representative religious and political leaders to use or abuse such knowledge as acquired by scientific research. It is the society at large and not the individual scientists who should take the responsibility for the use and/or abuse of scientific knowledge and inventions.

The ultimate responsibility for any abuse of scientific knowledge lies with the people who have the means to allow or restrict such abuse. Scientists are in no way responsible for the abuse that other people may make of their inventions and discoveries. Or aren't they?

One scientist at least felt differently. That was Alfred Nobel.

Alfred Nobel and Dynamite
Alfred Bernhard Nobel was a Swedish chemist, known for his study of explosives (Fig. 5). In 1867 he patented dynamite. Later that year, he demonstrated this explosive for the first time, at a quarry in Redhill, Surrey, England. In 1876 he patented Gelignite, or blasting gelatin, which was a more powerful explosive than dynamite. As a result of these and other inventions Nobel became very wealthy. In 1888 a French newspaper published a

premature obituary in which Nobel was described as the merchant of death (Le marchand de la mort), who became rich by finding ways to kill more people faster than ever before. This among other things may have brought about his decision to leave a better legacy and maybe atone for his inventions. In 1895 Nobel signed his last will and testament and set aside the bulk of his estate to establish the five Nobel Prizes, to be awarded annually without distinction of nationality, three of them to be awarded for eminence in physical science, chemistry and medical science, the fourth for literary work and the fifth to be given to the person or society that renders the greatest service to the cause of international fraternity, in the suppression or reduction of standing armies, or in the establishment or furtherance of peace congresses.

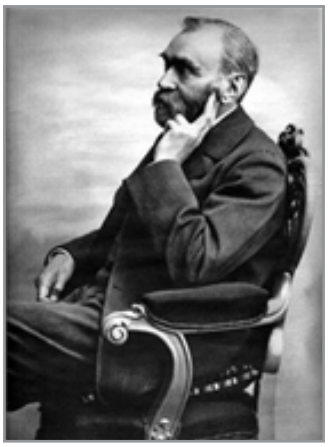


Figure 5: Alfred Bernhard Nobel

Since 1901, the prize has honored men and women for outstanding achievements in physics, chemistry, medicine, literature, and for work in peace. In 1921, the Nobel Prize in Physics was awarded to Albert Einstein (Fig, 6), "for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect".

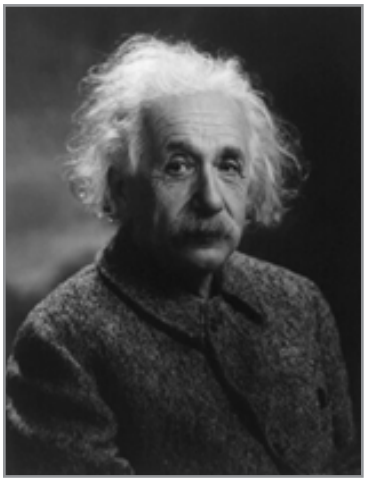
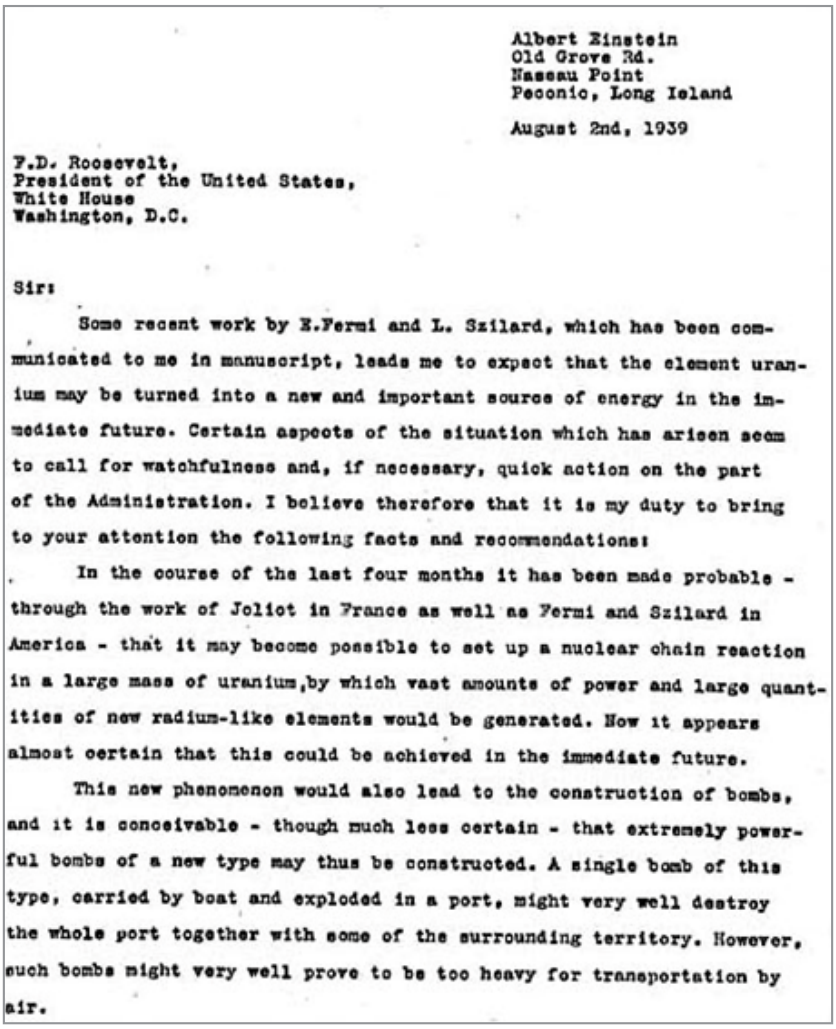


Figure 6: Albert Einstein

Albert Einstein and the Atomic Bomb

Some eighteen years afterwards, in August 1939, and just one month before the German invasion of Poland that precipitated the start of World War II, Albert Einstein, who was then a resident in the United States, wrote a letter to Franklin Roosevelt, President of the United States, in which he recommended that the US government give particular attention to the problem of securing a supply of uranium ore for the United States and speed up the experimental work on nuclear chain reactions (Fig. 7). The reason given for this recommendation was the rising possibility of setting up a nuclear chain reaction in a large mass of uranium by which vast amounts of power would be generated. “This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type, may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory.”



Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F.D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E.Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable - through the work of Joliot in France as well as Fermi and Szilard in America - that it may become possible to set up a nuclear chain reaction in a large mass of uranium,by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This new phenomenon would also lead to the construction of bombs, and it is conceivable - though much less certain - that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

Figure 7: The letter to Franklin Roosevelt

With this historic letter, Einstein gave the starting signal for the most horrible of weapons of mass destruction.

On October 19th, only eight days after his receipt of Einstein's letter, Roosevelt wrote Einstein back and informed him that he had set up a committee consisting of Sachs and representatives from the Army and Navy to study uranium. Roosevelt's approval of the Uranium Committee in October of 1939 was merely the first decision among many that ultimately led to the establishment of the only atomic bomb effort that succeeded in World War II - the Manhattan Project. With the setting up of this committee and the establishment of this project, a new era could be said to have begun, the era of weapons of mass destruction. The scientists who worked on developing the Atomic Bomb under the Manhattan Project included Robert Oppenheimer, David Bohm, Leo Szilard, Eugene Wigner, Otto Frisch, Rudolf Peierls, Felix Bloch, Niels Bohr, Emilio Segre, James Franck, Enrico Fermi, Klaus Fuchs and Edward Teller.

In 1941 the United States entered the War against Germany. In June 1945 seven eminent nuclear scientists drew up the so-called Franck Report in which they pointed out that "the success which we have achieved in the development of nuclear power is fraught with infinitely greater dangers than were all the inventions of the past". No attention was ever paid to this report. One month later, on July 16, 1945, the first atomic test was conducted in New Mexico. After viewing the results of this first atomic test, several participants signed petitions against losing the monster they had created, but their protests fell on deaf ears. On July 25, 1945 the official bombing order was issued. The order made no mention of targeting military objectives or sparing civilians. The cities themselves "Hiroshima, Kokura, Niigata and Nagasaki" were the targets. The order was also open-ended. "Additional bombs" could be dropped "as soon as made ready by the project staff."

Less than two weeks afterwards, on the morning of 6 August 1945, the United States dropped a uranium gun-type bomb code-named "Little Boy" (Fig. 8) on the Japanese city of Hiroshima, not on its military installations but on the civilian center of the city. Two planes participated in this mission, one to carry the bomb, the other to act as escort. Smoke billowed six kilometers above Hiroshima while smoke from the burst of the bomb spread over three kilometers on the target at the base of the rising column (Fig. 9). In an instant, 66,000 people were killed and 69,000 injured by the atomic explosion (V1). By the end of the year, injury and radiation brought total casualties to 140,000. Approx-

imately 70% of the city's buildings were completely destroyed, and 7 percent severely damaged. The area of total vaporization from the atomic blast measured one half mile in diameter; total destruction one mile in diameter; severe blast damage as much as two miles in diameter. Within a diameter of four kilometers, everything flammable burned. The remaining area of the blast zone was riddled with serious blazes that stretched out to the final edge at about five kilometers in diameter. Following the atomic bombing, the city population dropped from 420,000 in 1942 to 140,000. President Truman of the United States told the world that “the first atomic bomb was dropped on Hiroshima, a military base” (S1).

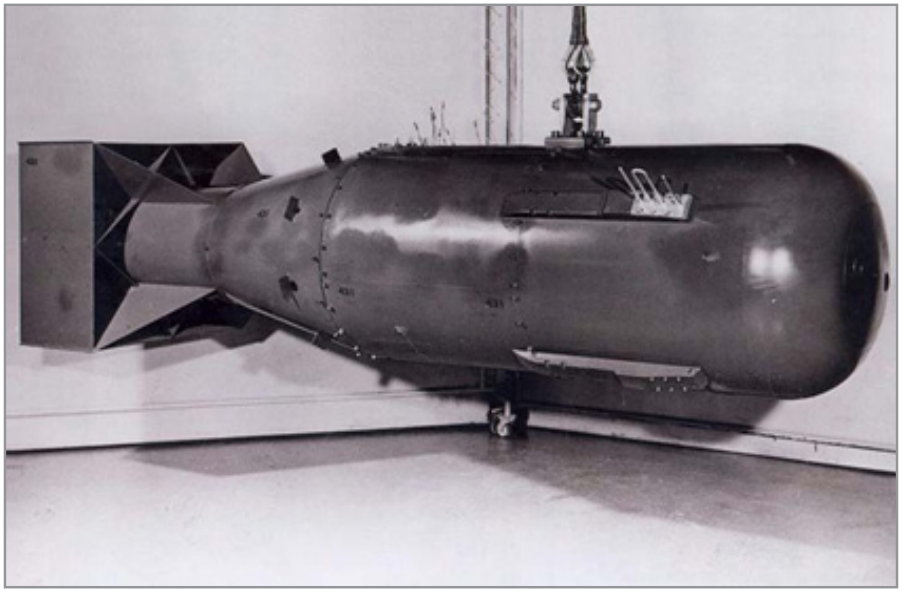


Figure 8: The uranium gun-type bomb code-named "Little Boy"

Of all the scientists working on the Manhattan Project, only one scientist, Joseph Rotblat, left the project on moral grounds after learning of the bombing of Hiroshima. He is reported to have remarked that he "became worried about the whole future of mankind." Rotblat would later work with Bertrand Russell on efforts to curb nuclear proliferation, collaborating with other scientists to compose what became known as the Russell–Einstein Manifesto, issued in London on July 9, 1955 by Bertrand Russell, which called for a conference where scientists would assess the dangers posed to the survival of humanity by weapons of mass destruction. Rotblat was awarded the Nobel Peace Prize in 1995.

While the people of Japan were trying to comprehend the devastation in Hiroshima, the United States was preparing a second bombing mission without giving Japan time to surrender. When a sufficient amount of plutonium-239 for the atomic bomb was ready, the United States dropped a second plutonium implosion-type bomb code-named "Fat Man" on the city of Nagasaki three days after the first blast. The bomb levelled nearly half the city (Fig. 10). In a split second, Nagasaki’s population dropped from 422,000 to 383,000. Over 70,000 people were injured. 80,000 people died by the end of the year. According to statistics given at the Nagasaki Peace Park, the number of people who suffered radiation-related diseases amounted to several hundred thousand.

Figure 9: Smoke from the burst of the bomb dropped on Hiroshima.

Figure 10: The American bomb levelled nearly half the city of Nagasaki.

In all some 220,000 people suffered immediate deaths in the two Japanese cities with thousands more killed over time because of injuries sustained and long-term radiation. Many survivors of the Hiroshima and Nagasaki blasts succumbed to radiation poisoning (Fig. 11). The destructive effects of the explosions did not stop there either. The atomic bomb detonation can also affect the future generations of those who lived through it. Leukaemia is among the greatest of afflictions that are passed on to the offspring of survivors.

Figure 11: photograph of the effects of Atomic Heat and Radiation on Humans in Hiroshima

By way of contrast, some fourteen centuries earlier, the Prophet Muhammad fought the heathens in Arabia for ten years in a series of battles that led eventually to the unification of Arabia for the first and only time in its history. The total number of all people Muslims and non-Muslims killed in all these wars was a few hundreds, which is a tiny fraction, less than 0.2 %, of the people killed in three days in the two Japanese cities.

As of 2006, there are estimated to be at least 27,000 nuclear weapons held by at least eight countries, 96 percent of them in the possession of the United States and Russia. As Bertrand Russell put it in his speech to the British House of Lords, the gravity of the possibilities of evil that lie in the utilization of atomic energy cannot be exaggerated. The world may still end, not with a whimper as thought by T. S. Eliot in Hollow men, but with a big nuclear bang.

Was Einstein, a Nobel laureate, and the American scientists working on nuclear chain reactions and later on the Manhattan Project responsible directly or indirectly for the deaths and injuries and devastations that have resulted or may yet result from the dropping of atomic bombs. In view of the Frank and other reports and petitions, we know the “the scientists themselves felt extremely uneasy with a very bad conscience about what they had done”. As for Einstein, although very troubled for his part in the development of the atomic bomb, he withheld public comment on the atomic bombing of Japan until a year afterward. He later wrote, "I have always condemned the use of the atomic bomb against Japan."

In an apology to his biographer Antonina Vallentin he is reported to have said. "I really only acted as a mail box. They (Szilard, et al) brought me a finished letter and I simply signed it". But, five months before his death, in November 1954, Einstein summarized his feelings about his role in the creation of the atomic bomb by saying "I made one great mistake in my life... when I signed the letter to President Roosevelt recommending that atom bombs be made; but there was some justification - the danger that the Germans would make them". But as we have seen, the Einstein letter was written one month before the start of the war with Germany, and two years before the United States was directly involved. Furthermore, Germany surrendered on May 7, 1945, two months before the conduction of the first atomic test which took place in July 1945.

To every action great or small follows a consequence. The consequences of every act are included in the act itself, and as the mystic Jalaluddin Arroumi said, the world is but a mountain that echoes back our actions [3]. It cannot be denied that the work of Einstein and the other scientists led directly to the making of the atomic bomb, which in turn led to the killing of countless innocent civilians in the two Japanese cities. According to Bertrand Russell, a considerable proportion of the men of science, who invent continually more elaborate methods of attack and defence, must be added to the class of people whose labours are devoted to the end of international competition and war.

And just as soldiers and generals engaged in offensive wars cannot claim innocence and freedom from guilt for the killing of people and the destruction of property, so scientists working on the development of more advanced weapons and instruments of war cannot claim innocence and freedom from guilt for such killing and destruction and other actions that are consequences of their inventions and work. Yet, scientists are often honored for their work and absolved of any guilt regarding the consequences of their discoveries in the same way that the actions of soldiers and generals engaged in offensive wars are often excused or even considered noble and great.

For the way people consider and interpret killing and murder is rather revealing. Two radically opposing views are often implicitly held. The first, a minority view, is that expressed in the Koran, which states that killing one person is tantamount to killing all of mankind, for wanton killing is a crime, be it the killing of one person or the killing of many.

In the story of Cain and Abel as told in the Koran, Abel is slain by his brother (Fig. 12). The Koran comments that whosoever killed a human being, except as a punishment for murder or for perpetrating wicked crimes and violence in the land, is to be looked upon as though he had killed all mankind, and that whosoever saved a human life is to be regarded as though he had saved all mankind [4].

Figure 12: The First Mourning (Premier Deuil)
William Bouguereau (1825-1905)

The other and opposing view held by most people in most nations is that to kill one person is certainly a crime, but to be the cause of the deaths of hundreds and thousands of people can be a noble or a patriotic act.

Whether sanctioned or approved by their societies or not, generals and soldiers cannot in good faith avoid being responsible for their actions. In a similar manner, scientists cannot in good faith ignore the consequences, often grave, of their own inventions

and discoveries. Scientists may choose to believe that the ultimate aim of their work is for the benefit of humanity and for the common good, and they may be sincere in this belief, but that does not make such a belief less fallacious, given the actual facts.

On July 15, 1955, a group of scientists, all Nobel laureates, met in the island of Mainau. In the statement they signed it was said: "We have been happy to devote a lifetime to the service of Science, for we think that Science is a way to a fuller life for mankind. But we are alarmed when realizing that it is this very Science which now provides man with the means of self-destruction."

Writing back in 1923 on science and the future, Haldane wrote: "Man armed with science is like a baby armed with a box of matches. So far from being an isolated phenomenon, the late war (i.e. the first world war) is only an example of the disruptive result that we may constantly expect from the progress of science" [5].

In a nutshell, as Bertrand Russell puts it: "Man has survived, hitherto, through ignorance. Can he continue to survive now that the useful degree of ignorance is lost? .... The danger comes, not from Man's physical or biological environment, but from himself."

To Some people it might seem ironic that The Nobel prize which Nobel had intended as an atonement for his invention of dynamite, to be awarded to people who render the greatest service to the cause of international fraternity, in the suppression or reduction of standing armies, or in the establishment or furtherance of peace congresses, should be awarded to scientists who helped in the development of the atomic bomb whose power of destruction is many times greater than that of dynamite!

A particularly poignant and salient example is that provided by the Russian author and novelist Aleksandr Solzhenitsyn in one of his novels, where a group of scientists imprisoned for their beliefs by the Russian Communist system work in prison on projects that are of direct and immediate benefit to the state police that is responsible for their incarceration and humiliation.

Given the above all too real dilemmas, scientists may not be wholly responsible for the abuse of their discoveries. At the same time, they cannot be totally absolved of all responsibility, particularly in situations where they cannot plead ignorance of the possible results of their inventions and discoveries.

Conclusion

All can be said about the consequences of scientific inventions and discoveries and the individual responsibility of scientists is that scientists will continue to do research as long as men of power provide them with the political and material support essential for their work, and men of power will continue to use or abuse as they see fit whatever discoveries or inventions the scientists make available with no regard to the wishes or recommendations of scientists and regardless of what scientists pretend, or like, to believe about the matter. With the dangers inherent in the present-day scientific knowledge, the catastrophes warned about by such men as Haldane and Bertrand Russell cannot be ruled out. We may still hope for the best, but our hope will not be based on solid foundations.

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