NUCLEAR WEAPONS: AN ABSOLUTE EVIL

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November 19, 2017

Introduction

The threat of nuclear war is very high today

This book is a collection of articles and book chapters that I have written advocating the abolition of nuclear weapons. Some new material has also been added, for example a discussion of the Nuclear Weapons Convention which has recently been adopted by an overwhelming majority vote at the United Nations General Assembly.

Today, because of the possibility that U.S. President Donald Trump will initiate a nuclear war against Iran or North Korea, or even Russia, the issue of nuclear weapons is at the center of the global stage. I strongly believe that the time has come for all countries to take a united stance on this issue. Most of the world's nations live in nuclear weapon free zones. This does not give them any real protection, since the catastrophic environmental effects of nuclear war would be global, not sparing any nation. However, by supporting the Nuclear Weapons Convention and by becoming members of NWFZ's, nations can state that they consider nuclear weapons to be morally unacceptable, a view that must soon become worldwide if human civilization is to survive.

We must take a stand, and state clearly that nuclear weapons are an absolute evil; that their possession does not increase anyone's security; that their continued existence is a threat to the life of every person on the planet; and that these genocidal and potentially omnicidal weapons have no place in a civilized society.

Nuclear warfare as genocide

On December 9, 1948, the United Nations General Assembly adopted a convention prohibiting genocide. It seems appropriate to discuss nuclear warefare against the background of this important standard of international law.

Cannot nuclear warfare be seen as an example of genocide? It is capable of killing entire populations, including babies, young children, adults in their prime and old people, without any regard for guilt or innocence. The retention of nuclear weapons, with the intent to use them under some circumstances, must be seen as the intent to commit genocide. Is it not morally degrading to see our leaders announce their intention to commit the "crime of crimes" in our names?

The use of nuclear weapons potentially involves not only genocide, but also omnicide, the death of all, since a large-scale thermonuclear war would destroy human civilization and much of the biosphere.

If humanity is to survive, we must develop an advanced ethic to match our advanced technology. We must regard all humans as our brothers and sisters, More than that, we must actively feel our kinship with all living things, and accept and act upon our duty to protect both animate and inanimate nature.

Science is double-edged

Modern science has, for the first time in history, offered humankind the possibility of a life of comfort, free from hunger and cold, and free from the constant threat of death through infectious disease. At the same time,science has given humans the power to obliterate their civilization with nuclear weapons, or to make the earth uninhabitable through overpopulation and pollution. The question of which of these paths we choose is literally a matter of life or death for ourselves and our children.

Will we use the discoveries of modern science constructively, and thus choose the path leading towards life? Or will we use science to produce more and more lethal weapons, which sooner or later, through a technical or human failure, may result in a catastrophic nuclear war? Will we thoughtlessly destroy our beautiful planet through unlimited growth of population and industry? The choice among these alternatives is ours to make. We live at a critical moment of history - a moment of crisis for civilization.

No one living today asked to be born at such a moment, But history has given our generation an enormous responsibility, and two daunting tasks: We must abolish nuclear weapons and we must abolish institution of war.

The continuity of life is sacred

In 1985, International Physicians for the Prevention of Nuclear War received the Nobel Peace Prize. IPPNW had been founded in 1980 by six physicians, three from the Soviet Union and three from the United States. Today, the organization has wide membership among the world's physicians. Professor Bernard Lowen of the Harvard School of Public Health, one of the founders of IPPNW, said in a recent speech:

"...No public health hazard ever faced by humankind equals the threat of nuclear war. Never before has man possessed the destructive resources to make this planet uninhabitable... Modern medicine has nothing to offer, not even a token benefit, in the event of nuclear war..."

"We are but transient passengers on this planet Earth. It does not belong to us. We are not free to doom generations yet unborn. We are not at liberty to erase humanity's past or dim its future. Social systems do not endure for eternity. Only life can lay claim to uninterrupted continuity. This continuity is sacred."

Mr. Javier Pérez de Cuéllar , former Secretary-General of the United Nations, emphasized the same point in one of his speeches: "I feel", he said, "that the question may justifiably be put to the leading nuclear powers: by what right do they decide the fate of humanity? From Scandinavia to Latin America, from Europe and Africa to the Far East, the destiny of every man and woman is affected by their actions. No one can expect to escape from the catastrophic consequences of a nuclear war on the fragile structure of this planet. ..."

"No ideological confrontation can be allowed to jeopardize the future of humanity. Nothing less is at stake: todays decisions affect not only the present; they also put at risk succeeding generations. Like supreme arbiters, with our disputes of the moment, we threaten to cut off the future and to extinguish the lives of innocent millions yet unborn. There can be no greater arrogance. At the same time, the lives of all those who lived before us may be rendered meaningless; for we have the power to dissolve in a conflict of hours or minutes the entire work of civilization, with all the brilliant cultural heritage of humankind.

"...In a nuclear age, decisions affecting war and peace cannot be left to military strategists or even to governments. They are indeed the responsibility of every man and woman. And it is therefore the responsibility of all of us... to break the cycle of mistrust and insecurity and to respond to humanity's yearning for peace."

The threat of nuclear war

As bad as conventional arms and conventional weapons may be, it is the possibility of a catastrophic nuclear war that poses the greatest threat to humanity. There are today roughly 16,000 nuclear warheads in the world. The total explosive power of the warheads that exist or that could be made on short notice is approximately equal to 500,000 Hiroshima bombs.

To multiply the tragedy of Hiroshima by a factor of half a million makes an enormous difference, not only quantitatively, but also qualitatively. Those who have studied the question believe that a nuclear catastrophe today would inflict irreversible damage on our civilization, genetic pool and environment.

Thermonuclear weapons consist of an inner core where the fission of uranium-235 or plutonium takes place. The fission reaction in the core is able to start a fusion reaction in the next layer, which contains isotopes of hydrogen. It is possible to add a casing of ordinary uranium outside the hydrogen layer, and under the extreme conditions produced by the fusion reaction, this ordinary uranium can undergo fission. In this way, a fission-fusion-fission bomb of almost limitless power can be produced.

The danger of a catastrophic nuclear war casts a dark shadow over the future of our species. It also casts a very black shadow over the future of the global environment. The environmental consequences of a massive exchange of nuclear weapons have been treated in a number of studies by meteorologists and other experts from both East and West. They predict that a large-scale use of nuclear weapons would result in fire storms with very high winds and high temperatures, which would burn a large proportion of the wild land fuels in the affected nations. The resulting smoke and dust would block out sunlight for a period of many months, at first only in the northern hemisphere but later also in the southern hemisphere.

Temperatures in many places would fall far below freezing, and much of the earth's plant life would be killed. Animals and humans would then die of starvation. The nuclear winter effect was first discovered as a result of the Mariner 9 spacecraft exploration of Mars in 1971. The spacecraft arrived in the middle of an enormous dust-storm on Mars, and measured a large temperature drop at the surface of the planet, accompanied by a heating of the upper atmosphere. These measurements allowed scientists to check their theoretical models for predicting the effect of dust and other pollutants distributed in planetary atmospheres.

Flaws in the concept of nuclear deterrence

A number of prominent political and military figures (many of whom have ample knowledge of the system of deterrence, having been part of it) have expressed concern about the danger of accidental nuclear war. Colin S. Gray, Chairman, National Institute for Public Policy, expressed this concern as follows: "The problem, indeed the enduring problem, is that we are resting our future upon a nuclear deterrence system concerning which we cannot tolerate even a single malfunction". General Curtis E. LeMay, Founder and former Commander in Chief of the United States Strategic Air Command, has written, "In my opinion a general war will grow through a series of political miscalculations and accidents rather than through any deliberate attack by either side. Bruce G. Blair (Brookings Institute) has remarked that "It is obvious that the rushed nature of the process, from warning to decision to action, risks causing a catastrophic mistake... This system is an accident waiting to happen."

Fred Ikle of the Rand Corporation has written, "Given the huge and far-flung missile forces, ready to be launched from land and sea on both sides, the scope for disaster by accident is immense... In a matter of seconds through technical accident or human failure mutual deterrence might thus collapse."

Another serious failure of the concept of nuclear deterrence is that it does not take into account the possibility that atomic bombs may be used by terrorists. Indeed, the threat of nuclear terrorism has today become one of the most pressing dangers that the world faces, a danger that is particularly acute in the United States.

Since 1945, more than 3,000 metric tons (3,000,000 kilograms) of highly enriched uranium and plutonium have been produced - enough for several hundred thousand nuclear weapons. Of this, roughly a million kilograms are in Russia, inadequately guarded, in establishments where the technicians are poorly paid and vulnerable to the temptations of bribery. There is a continuing danger that these fissile materials will fall into the hands of terrorists, or organized criminals, or irresponsible governments. Also, an extensive black market for fissile materials, nuclear weapons components etc. has recently been revealed in connection with the confessions of Pakistan's bomb-maker, Dr. A.Q. Khan. Furthermore, if Pakistans less-than-stable government should be overthrown, complete nuclear weapons could fall into the hands of terrorists.

Finally, the doctrine of nuclear deterrence resta on the assumption that political leaders have sound judgement. But what if the leaders are not entirely sane? We must ask this question in the context of the present conflict between the United States and North Korea.

Nuclear weapons are criminal! Every war is a crime!

War was always madness, always immoral, always the cause of unspeakable suffering, economic waste and widespread destruction, and always a source of poverty, hate, barbarism and endless cycles of revenge and counter-revenge. It has always been a crime for soldiers to kill people, just as it is a crime for murderers in civil society to kill people. No flag has ever been wide enough to cover up atrocities.

But today, the development of all-destroying modern weapons has put war completely beyond the bounds of sanity and elementary humanity.

Today, war is not only insane, but also a violation of international law. Both the United Nations Charter and the Nuremberg Principles make it a crime to launch an aggressive war. According to the Nuremberg Principles, every soldier is responsible for the crimes that he or she commits, even while acting under the orders of a superior officer.

Nuclear weapons are not only insane, immoral and potentially omnicidal, but also criminal under international law. In response to questions put to it by WHO and the UN General Assembly, the International Court of Justice ruled in 1996 that "the threat and use of nuclear weapons would generally be contrary to the rules of international law applicable in armed conflict, and particularly the principles and rules of humanitarian law." The only possible exception to this general rule might be "an extreme circumstance of self-defense, in which the very survival of a state would be at stake". But the Court refused to say that even in this extreme circumstance the threat or use of nuclear weapons would be legal. It left the exceptional case undecided. In addition, the Court added unanimously that "there exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control."

Can we not rid ourselves of both nuclear weapons and the institution of war itself? We must act quickly and resolutely before everything that we love in our beautiful world is reduced to radioactive ashes.

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Chapter 1

ATOMIC AND NUCLEAR PHYSICS

The discovery of electrons

In the late 1880's and early a 1890's, a feeling of satisfaction, perhaps even smugness, prevailed in the international community of physicists. It seemed to many that Maxwell's electromagnetic equations, together with Newton's equations of motion and gravitation, were the fundamental equations which could explain all the phenomena of nature. Nothing remained for physicists to do (it was thought) except to apply these equations to particular problems and to deduce the consequences. The inductive side of physics was thought to be complete.

However, in the late 1890's, a series of revolutionary discoveries shocked the physicists out of their feeling of complacency and showed them how little they really knew. The first of these shocks was the discovery of a subatomic particle, the electron. In Germany, Julius Plücker (1801-1868), and his friend, Heinrich Geisler (1814-1879), had discovered that an electric current could be passed through the gas remaining in an almost completely evacuated glass tube, if the pressure were low enough and the voltage high enough. When this happened, the gas glowed, and sometimes the glass sides of the tube near the cathode (the negative terminal) also glowed. Plücker found that the position of the glowing spots on the glass near the cathode could be changed by applying a magnetic field.

In England, Sir William Crookes (1832-1919) repeated and improved the experiments of Plücker and Geisler: He showed that the glow on the glass was produced by rays of some kind, streaming from the cathode; and he demonstrated that these "cathode rays" could cast shadows, that they could turn a small wheel placed in their path, and that they heated the glass where they

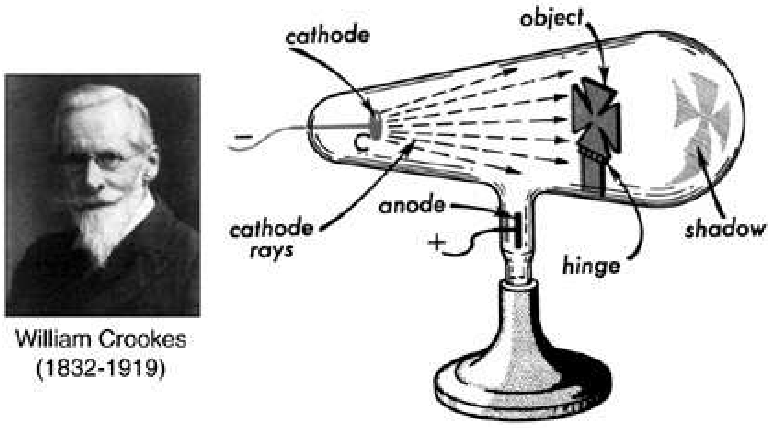

Figure 1.1: *Sir William Crookes showed that cathode rays could cast shadows. Source¿ nau.edu*

struck it.

Sir William Crookes believed that the cathode rays were electrically charged particles of a new kind - perhaps even a "fourth state of matter". His contemporaries laughed at these speculations; but a few years later a brilliant young physicist named J.J.Thomson (1856-1940), working at Cambridge University, entirely confirmed Crookes' belief that the cathode rays were charged particles of a new kind.

Thomson, an extraordinarily talented young scientist, had been appointed full professor and head of the Cavendish Laboratory at Cambridge at the age of 27. His predecessors in this position had been James Clerk Maxwell and the distinguished physicist, Lord Rayleigh, so the post was quite an honor for a man as young as Thomson. However, his brilliant performance fully justified the expectations of the committee which elected him. Under Thomson's direction, and later under the direction of his student, Ernest Rutherford, the Cavendish Laboratory became the world's greatest center for atomic and subatomic research; and it maintained this position during the first part of the twentieth century.

J.J. Thomson's first achievement was to demonstrate conclusively that the "cathode rays" observed by Plücker, Geisler and Crookes were negatively charged particles. He and his students also measured their ratio of charge to mass. If the charge was the same as that on an ordinary negative ion-then the mass of the particles was astonishingly small - almost two thousand times smaller than the mass of a hydrogen atom! Since the hydrogen atom is the lightest of all atoms, this indicated that the cathode rays were *subatomic* particles.

The charge which the cathode rays particles carried was recognized to be the fundamental unit of electrical charge, and they were given the name "electrons". All charges observed in nature were found to be integral multiples of the charge on an electron. The discovery of the electron was the first clue that the atom, thought for so long to be eternal and indivisible, could actually be torn to pieces.

X-rays

In 1895, while the work leading to the discovery of the electron was still going on, a second revolutionary discovery was made. In the autumn of that year, Wilhelm Konrad Roentgen (1845-1923), the head of the department of physics at the University of Würtzburg in Bavaria, was working with a discharge tube, repeating some of the experiments of Crookes.

Roentgen was especially interested in the luminescence of certain materials when they were struck by cathode rays. He darkened the room, and turned on the high voltage. As the current surged across the tube, a flash of light came from an entirely different part of the room! To Roentgen's astonishment, he found that a piece of paper which he had coated with barium platinocyanide was glowing brightly, even though it was so far away from the discharge tube that the cathode rays could not possibly reach it!

Roentgen turned off the tube, and the light from the coated paper disappeared. He turned on the tube again, and the bright glow on the screen reappeared. He carried the coated screen into the next room. Still it glowed! Again he turned off the tube, and again the screen stopped glowing. Roentgen realized that he had discovered something completely strange and new. Radiation of some kind was coming from his discharge tube, but the new kind of radiation could penetrate opaque matter!

Years later, when someone asked Roentgen what he thought when he discovered X-rays, he replied: "I didn't think. I experimented!" During the next seven weeks he experimented like a madman; and when he finally announced his discovery in December, 1895, he was able to report all of the most important properties of X-rays, including their ability to ionize gases and the fact that they cannot be deflected by electric or magnetic fields. Roentgen correctly believed X-rays to be electromagnetic waves, just like light waves, but with very much shorter wavelength.

It turned out that X-rays were produced by electrons from the cathode of the discharge tube. These electrons were accelerated by the strong electric field as they passed across the tube from the cathode (the negative terminal) to the anode (the positive terminal). They struck the platinum anode with

Figure 1.2: *Wilhelm Konrad Roentgen (1845-1923) Wellcome Images, [CC BY-SA 4.0], Wikimedia Commons*

Figure 1.3: *X-ray photograph by W.K. Roentgen. Wellcome Images, [CC BY-SA 4.0], Wikimedia Commons*

very high velocity, knocking electrons out of the inner parts of the platinum atoms. As the outer electrons fell inward to replace these lost inner electrons, electromagnetic waves of very high frequency were emitted.

On January 23, 1896, Roentgen gave the first public lecture on X-rays; and in this lecture he demonstrated to his audience that X-ray photographs could be used for medical diagnosis. When Roentgen called for a volunteer from the audience, the 79 year old physiologist, Rudolf von Kölliker stepped up to the platform, and an X-ray photograph was taken of the old man's hand. The photograph, still in existence, shows the bones beautifully.

Wild enthusiasm for Roentgen's discovery swept across Europe and America, and soon many laboratories were experimenting with X-rays. The excitement about X-rays led indirectly to a third revolutionary discovery - radioactivity.

Radioactivity

On the 20th of January, 1896, only a month after Roentgen announced his discovery, an excited crowd of scientists gathered in Paris to hear the mathematical physicist Henri Poincaré lecture on Roentgen's X-rays. Among them was Henri Becquerel (1852-1908), a professor of physics working at the Paris Museum of Natural History and the École Polytechnique. Becquerel, with his neatly clipped beard, looked the very picture of a 19th century French professor; and indeed, he came from a family of scientists. His grandfather had been a pioneer of electrochemistry, and his father had done research on fluorescence and phosphorescence.

Like his father, Henri Becquerel was studying fluorescence and phosphorescence; and for this reason he was especially excited by the news of Roentgen's discovery. He wondered whether there might be X-rays among the rays emitted by fluorescent substances. Hurrying to his laboratory, Becquerel prepared an experiment to answer this question.

He wrapped a large number of photographic plates in black paper, so that ordinary light could not reach them. Then he carried the plates outdoors into the sunlight, and on each plate he placed a sample of a fluorescent compound from his collection. After several hours of exposure, he developed the plates. If X-rays were present in the fluorescent radiation, then the photographic plates should be darkened, even though they were wrapped in black paper.

When he developed the plates, he found, to his excitement, that although most of them were unaffected, one of the plates was darkened! This was the plate on which he had placed the compound, potassium uranium sulfate. Experimenting further, Becquerel found other compounds which would darken the photographic plates - sodium uranium sulfate, ammonium uranium sulfate and uranium nitrate. All were compounds of uranium!

At the end of February, Becquerel made his first report to the French Academy of Sciences; and until the end of March, he brought a new report every week, describing new properties of the remarkable radiation from uranium compounds. Then the weather turned against him, and for many weeks, Paris was covered with thick clouds. Too impatient to wait for sunshine, Becquerel continued his experiments in cloudy weather, hoping that even without direct sunlight there would be some slight effect.

To his astonishment, the plates were blackened as much as before, although without direct sunlight the fluorescence of the uranium compounds was much diminished! Could it be that the mysterious penetrating radiation from the uranium compounds was independent of fluorescence? To answer this question, Becquerel next tried placing the uranium-containing compounds on photographic plates in a completely darkened room. Still the plates were blackened! The effect was completely independent of exposure to sunlight!

This was indeed something completely new and strange: The radiation seemed to come from the uranium atoms themselves, rather than from chemical changes in the compounds to which the atoms belonged. If the energy of

Becquerel's rays did not come from sunlight, what was its source? Two of the most basic assumptions of classical science seemed to be challenged - the indivisibility of the atom and the conservation of energy.

Marie and Pierre Curie

Among Henri Becquerel's colleagues in Paris were two dedicated and talented scientists, Marie and Pierre Curie. As a boy, Pierre Curie (1859-1906), the son of an intellectual Parisian doctor, had never been to school. His father had educated him privately, recognizing that his son's original and unworldly mind was unsuited for an ordinary education.

At the age of 16, Pierre Curie had become a Bachelor of Science, and at 18, he had a Master's degree in physics. Together with his brother, Jacques, Pierre Curie had discovered the phenomenon of piezoelectricity - the electrical potential produced when certain crystals, such as quartz, are compressed. He had also discovered a law governing the temperature-dependence of magnetism, "Curie's Law".

Although Pierre Curie had an international reputation as a physicist, his position as chief of the laboratory at the School of Physics and Chemistry of the City of Paris was miserably paid; and his modest, unworldly character prevented him from seeking a better position. He only wanted to be allowed to continue his research.

In 1896, when Becquerel announced his revolutionary discovery of radioactivity, Pierre Curie was newly married to a Polish girl, much younger than himself, but equally exceptional in character and ability. Marie Sklodowska Curie (1867-1934) had been born in Warsaw, in a Poland which did not officially exist, since it had been partitioned between Germany, Austria and Russia. Her father was a teacher of mathematics and physics and her mother was the principal of a girl's school.

Marie Sklodowska's family was a gifted one, with strong intellectual traditions; but it was difficult for her to obtain a higher education in Poland. Her mother died, and her father's job was withdrawn by the government. Marie Sklodowska was forced to work in a humiliating position as a governess in a uncultured family, meanwhile struggling to educate herself by reading books of physics and mathematics. She had a romance with the son of a Polish landowning family; but in the end, he rejected her because of her inferior social position.

Marie Sklodowska transmuted her unhappiness and humiliation into a fanatical devotion to science. She once wrote to her brother: "You must believe yourself to be born with a gift for some particular thing; and you must achieve that thing, no matter what the cost." Although she could not know it at the time, she was destined to become the greatest woman scientist in history.

Marie Sklodowska's chance for a higher education came at last when her married sister, who was studying medicine in Paris, invited Marie to live with her there and to enroll in the Sorbonne. After living in Paris with her sister for a year while studying physics, Marie found her sister's household too distracting for total concentration. She moved to a tiny, comfortless garret room, where she could be alone with her work.

Rejecting all social life, enduring freezing temperatures in winter, and sometimes fainting from hunger because she was too poor to afford proper food, Marie Sklodowska was nevertheless completely happy because at last she had the chance to study and to develop her potentialities. She graduated from the Sorbonne at the top of her class.

Pierre Curie had decided never to marry. He intended to devote himself totally to science; but when he met Marie, he recognized in her a person with whom he could share his ideals and his devotion to his work. After some hesitation by Marie, to whom the idea of leaving Poland forever seemed like treason, they were married. They spent a happy honeymoon touring the countryside of France on a pair of bicycles.

The next step for the young Polish student, who had now become Madame Curie, was to begin research for a doctor's degree; and she had to decide on a topic of research. The year was 1896, and news of Becquerel's remarkable discovery had just burst upon the scientific world. Marie Curie decided to make Becquerel's rays the topic of her thesis.

Using a sensitive electrometer invented by Pierre and Jacques Curie, she systematically examined all the elements to see whether any others besides uranium produced the strange penetrating rays. Almost at once, she made an important discovery: Thorium was also radioactive; but besides uranium and thorium, none of the other elements made the air of her ionization chamber' conduct electricity, discharging the electrometer. Among the known elements, only uranium and thorium were radioactive.

Next, Marie Curie tested all the compounds and minerals in the collection at the School of Physics. One of the minerals in the collection was pitchblend, an ore from which uranium can be extracted. She of course expected this uranium-containing ore to be radioactive; but to her astonishment, her measurements showed that the pitchblende was much *more* radioactive than could be accounted for by its content of uranium and thorium!

Since both Marie Curie's own work, and that of Becquerel, had shown radioactivity to be an atomic property, and since, among the known elements, the only two radioactive ones were uranium and thorium, she and her husband were forced to the inescapable conclusion that the pitchblende must contain

Figure 1.4: *Pierre Curie, (1859-1906). He shared the 1903 Nobel Prize in Physics with his wife Marie. Public domain, Wikimedia Commons*

small traces of a new, undiscovered, highly radioactive element, which had escaped notice in the chemical analysis of the ore.

At this point, Pierre Curie abandoned his own research and joined Marie in an attempt to find the unknown element which they believed must exist in pitchblende. By July, 1898, they had isolated a tiny amount of a new element, a hundred times more radioactive than uranium. They named it "polonium" after Marie's native country.

By this time, however, they had discovered that the extra radioactivity of pitchblende came from not one, but at least two new elements. The second undiscovered element, however, was enormously radioactive, and present only in infinitesimal concentrations. They realized that, in order to isolate a weighable amount of it, they would have to begin with huge amounts of raw pitchblende ore.

The Curies wrote to the directors of the mines at St. Joachimsthal in Bohemia, where silver was extracted from pitchblende, and begged for a few tons of the residue left after the extraction process. When they received a positive reply, they spent their small savings to pay the transportation costs.

The only place the Curies could find to work with the pitchblende ore was an old shed with a leaky roof - a chillingly cold place in the winter. Remembering the four years which she and her husband spent in this shed, Marie Curie wrote:

"This period was, for my husband and myself, the heroic period of our common existence... It was in this miserable old shed that the best and happiest years of our lives were spent, entirely consecrated to work. I sometimes passed the whole day stirring a boiling mass of material with an iron rod nearly as big as myself. In the evening, I was broken with fatigue... I came to treat as many as twenty kilograms of matter at a time, which had the effect of filling the shed with great jars full of precipitates and liquids. It was killing work to carry the receivers, to pour off the liquids and to stir for hours at a stretch the boiling matter in a smelting basin."

Marie and Pierre Curie began by separating the ore into fractions by various chemical treatments. After each treatment, they tested the fractions by measuring their radioactivity. They could easily see which fraction contained the highly radioactive unknown element. The new element, which they named "radium", had chemical properties almost identical to those of barium; and the Curies found that it was almost impossible to separate radium from barium by ordinary chemical means.

In the end, they resorted to fractional crystalization, repeated several thousand times. At each step, the radium concentration of the active fraction was slightly enriched, and the radioactivity became progressively stronger. Finally it was two million times as great as the radioactivity of uranium. One evening, when Marie and Pierre Curie entered their laboratory without lighting the lamps, they saw that all their concentrated samples were glowing in the dark.

After four years of backbreaking labor, the Curies isolated a small amount of pure radium and measured its atomic weight. This achievement, together with their other work on radioactivity, brought them the 1903 Nobel Prize in Physics (shared with Becquerel), as well as worldwide fame. Madame Curie, the first great woman scientist in history, became a symbol of what women could do. The surge of public enthusiasm, which had started with Roentgen's discovery of X-rays, reached a climax with Madame Curie's isolation of radium.

It had been discovered that radium was helpful in treating cancer; and Madame Curie was portrayed by newspapers of the period as a great humanitarian. Indeed, the motives which inspired Marie and Pierre Curie to their heroic labors were both humanitarian and idealistic. They believed that only good could come from any increase in human knowledge. They did not know that radium is also a dangerous element, capable of causing cancer as well as curing it; and they could not forsee that research on radioactivity would eventually lead to nuclear weapons.

Figure 1.5: *Marie Curie. Nobel Prize in Physics photo (1903). Later, she also won the Nobel Prize in Chemistry. Public domain, Wikimedia Commons*

Rutherford's model of the atom

In 1895, the year during which Roentgen made his revolutionary discovery of X-rays, a young New Zealander named Ernest Rutherford was digging potatoes on his father's farm, when news reached him that he had won a scholarship for advanced study in England. Throwing down his spade, Rutherford said, "That's the last potato I'll dig!" He postponed his marriage plans and sailed for England, where he enrolled as a research student at Cambridge University. He began work at the Cavendish Laboratory, under the leadership of J.J. Thomson, the discoverer of the electron.

In New Zealand, Rutherford had done pioneering work on the detection of radio waves, and he probably would have continued this work at Cambridge, if it had not been for the excitement caused by the discoveries of Roentgen and Becquerel. Remembering this period of his life, Rutherford wrote:

"Few of you can realize the enormous sensation caused by the discovery of X-rays by Roentgen in 1895. It interested not only the scientific man, but also the man in the street, who was excited by the idea of seeing his own insides and his bones. Every laboratory in the world took out its old Crookes' tubes to produce X-rays, and the Cavendish was no exception."

J.J. Thomson, who was interested in studying ions (charged atoms or molecules) in gases, soon found that gaseous ions could be produced very conveniently by means of X-rays. Rutherford abandoned his research on radio waves, and joined Thomson in this work.

"When I entered the Cavendish Laboratory", Rutherford remembered later, "I began to work on the ionization of gases by means of X-rays. After reading the paper of Becquerel, I was curious to know whether the ions produced by the radiation from uranium were of the same nature as those produced by X-rays; and in particular, I was interested because Becquerel thought that his radiation was somehow intermediate between light and X-rays."

"I therefore proceeded to make a systematic examination of the radiation, and I found that it was of two types - one which produced intense ionization, and which was absorbed by a few centimeters of air, and the other, which produced less intense ionization, but was more penetrating. I called these alpha rays and beta rays respectively; and when, in 1898, Villard discovered a still more penetrating type of radiation, he called it gamma-radiation."

Rutherford later showed that the alpha-rays were actually ionized helium atoms thrown out at enormous velocities by the decaying uranium, and that beta-rays were high-speed electrons. The gamma-rays turned out to be electromagnetic waves, just like light waves, but of extremely short wavelength.

Rutherford returned briefly to New Zealand to marry his sweetheart, Mary Newton; and then he went to Canada, where he had been offered a post as

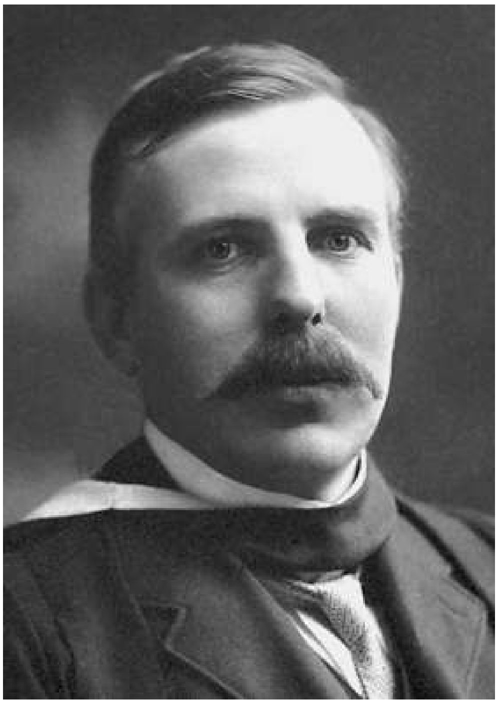

Figure 1.6: *Rutherford receivng the 1908 Nobel Prize in Chemistry. Public domain, Wikimedia Commons*

Professor of Physics at McGill University. In Canada, with the collaboration of the chemist, Frederick Soddy (1877-1956), Rutherford continued his experiments on radioactivity, and worked out a revolutionary theory of transmutation of the elements through radioactive decay.

During the middle ages, alchemists had tried to change lead and mercury into gold. Later, chemists had convinced themselves that it was impossible to change one element into another. Rutherford and Soddy now claimed that radioactive decay involves a whole series of transmutations, in which one element changes into another!

Returning to England as head of the physics department at Manchester University, Rutherford continued to experiment with alpha-particles. He was especially interested in the way they were deflected by thin metal foils. Rutherford and his assistant, Hans Geiger (1886-1945), found that most of the alpha-particles passed through a metal foil with only a very slight deflection, of the order of one degree.

In 1911, a young research student named Ernest Marsden joined the group, and Rutherford had to find a project for him. What happened next, in Rutherford's own words, was as follows:

"One day, Geiger came to me and said, 'Don't you think that young Marsden, whom I'm training in radioactive methods, ought to begin a small research?' Now I had thought that too, so I said, 'Why not let him see if any alpha-particles can be scattered through a large angle?' I may tell you in confidence that I did not believe that they would be, since we knew that the alpha-particle was a very fast, massive particle, with a great deal of energy; and you could show that if the scattering was due to the accumulated effect of a number of small scatterings, the chance of an alpha-particle's being scattered backward was very small."

"Then I remember two or three days later, Geiger coming to me in great excitement and saying, 'We have been able to get some of the alpha-particles coming backwards'. It was quite the most incredible event that has ever happened to me in my life. It was almost as incredible as if you fired a 15-inch shell at a piece of tissue paper and it came back and hit you."

"On consideration, I realized that this scattering backwards must be the result of a single collision, and when I made calculations, I found that it was impossible to get anything of that order of magnitude unless you took a system in which the greater part of the mass of the atom was concentrated in a minute nucleus."

"It was then that I had the idea of an atom with a minute massive center carrying a charge. I worked out mathematically what laws the scattering should obey, and found that the number of particles scattered through a given angle should be proportional to the thickness of the scattering foil, the square of the nuclear charge, and inversely proportional to the fourth power of the velocity. These deductions were later verified by Geiger and Marsden in a series of beautiful experiments."

Planck, Einstein and Bohr

According to the model proposed by Rutherford in 1911, every atom has an extremely tiny nucleus, which contains almost all of the mass of the atom. Around this tiny but massive nucleus, Rutherford visualized light, negatively-charged electrons circulating in orbits, like planets moving around the sun. Rutherford calculated that the diameter of the whole atom had to be several thousand times as large as the diameter of the nucleus.

Rutherford's model of the atom explained beautifully the scattering experiments of Geiger and Marsden, but at the same time it presented a serious difficulty: According to Maxwell's equations, the electrons circulating in their orbits around the nucleus ought to produce electromagnetic waves. It could easily be calculated that the electrons in Rutherford's atom ought to lose all their energy of motion to this radiation, and spiral in towards the nucleus. Thus, according to classical physics, Rutherford's atom could not be stable. It had to collapse.

The paradox was solved by Niels Bohr (1885-1962), a gifted young theoretical physicist from Copenhagen who had come to Manchester to work with Rutherford. Bohr was not at all surprised by the failure of classical concepts when applied to Rutherford's nuclear atom. Since he had been educated in Denmark, he was more familiar with the work of German physicists than were his English colleagues at Manchester. In particular, Bohr had studied the work of Max Planck (1858-1947) and Albert Einstein (1879-1955).

Just before the turn of the century, the German physicist, Max Planck, had been studying theoretically the electromagnetic radiation coming from a small hole in an oven. The hole radiated as though it were an ideally black body. This "black body radiation" was very puzzling to the physicists of the time, since classical physics failed to explain the frequency distribution of the radiation and its dependence on the temperature of the oven.

In 1901, Max Planck had discovered a formula which fitted beautifully with the experimental measurements of the frequency distribution of black body radiation; but in order to derive his formula, he had been forced to make a radical assumption which broke away completely from the concepts of classical physics.

Planck had been forced to assume that light (or, more generally, electromagnetic radiation of any kind) can only be emitted or absorbed in amounts of energy which Planck called "quanta". The amount of energy in each of these "quanta" was equal to the frequency of the light multiplied by a constant, h, which came to be known as "Planck's constant".

This was indeed a strange assumption! It seemed to have been pulled out of thin air; and it had no relation whatever to anything that had been discovered previously in physics. The only possible justification for Planck's quantum hypothesis was the brilliant success of his formula in explaining the puzzling frequency distribution of the black body radiation. Planck himself was greatly worried by his own radical break with classical concepts, and he spent many years trying unsuccessfully to relate his quantum hypothesis to classical physics.

In 1905, Albert Einstein published a paper in the *Annalen der Physik* in which he applied Planck's quantum hypothesis to the photoelectric effect. (At that time, Einstein was 25 years old, completely unknown, and working as a clerk at the Swiss Patent Office.) The photoelectric effect was another puzzling phenomenon which could not in any way be explained by classical physics. The German physicist Lenard had discovered in 1903 that light with a frequency above a certain threshold could knock electrons out of the surface of a metal; but below the threshold frequency, nothing at all happened, no matter how long the light was allowed to shine.

Using Planck's quantum hypothesis, Einstein offered the following explanation for the photoelectric effect: A certain minimum energy was needed to overcome the attractive forces which bound the electron to the metal surface. This energy was equal to the threshold frequency multiplied by Planck's constant. Light with a frequency equal to or higher than the threshold frequency could tear an electron out of the metal; but the quantum of energy supplied by light of a lower frequency was insufficient to overcome the attractive forces.

Einstein later used Planck's quantum formula to explain the low-temperature behavior of the specific heats of crystals, another puzzling phenomenon which defied explanation by classical physics. These contributions by Einstein were important, since without this supporting evidence it could be maintained that Planck's quantum hypothesis was an *ad hoc* assumption, introduced for the sole purpose of explaining black body radiation.

As a student, Niels Bohr had been profoundly impressed by the radical ideas of Planck and Einstein. In 1912, as he worked with Rutherford at Manchester, Bohr became convinced that the problem of saving Rutherford's atom from collapse could only be solved by means of Planck's quantum hypothesis.

Returning to Copenhagen, Bohr continued to struggle with the problem. In 1913, he found the solution: The electrons orbiting around the nucleus of an atom had "angular momentum". Assuming circular orbits, the angular momentum was given by the product of the mass and velocity of the electron,

Figure 1.7: *Niels Bohr and Albert Einstein in a photo by Paul Ehrenfest. Public domain, Wikimedia Commons*

multiplied by the radius of the orbit. Bohr introduced a quantum hypothesis similar to that of Planck: He assumed that the angular momentum of an electron in an allowed orbit, (multiplied by 2 pi), had to be equal to an integral multiple of Planck's constant. The lowest value of the integer, n=1, corresponded to the lowest allowed orbit. Thus, in Bohr's model, the collapse of Rutherford's atom was avoided.

Bohr calculated that the binding energies of the various allowed electron orbits in a hydrogen atom should be a constant divided by the square of the integer n; and he calculated the value of the constant to be 13.5 electron-Volts. This value fit exactly the observed ionization energy of hydrogen. After talking with the Danish spectroscopist, H.M. Hansen, Bohr realized with joy that by combining his formula for the allowed orbital energies with the Planck-Einstein formula relating energy to frequency, he could explain the mysterious line spectrum of hydrogen.

When Niels Bohr published all this in 1913, his paper produced agonized cries of "foul!" from the older generation of physicists. When Lord Rayleigh's son asked him if he had seen Bohr's paper, Rayleigh replied: "Yes, I have looked at it; but I saw that it was of no use to me. I do not say that discoveries may not be made in that sort of way. I think very likely they may be. But it does not suit me." However, as more and more atomic spectra and properties were explained by extensions of Niels Bohr's theories, it became clear that

Figure 1.8: *Another photo of Bohr and Einstein by Ehrenfest. Public domain, Wikimedia Commons*

Planck, Einstein and Bohr had uncovered a whole new stratum of phenomena, previously unsuspected, but of deep and fundamental importance.

Atomic numbers

Bohr's atomic theory soon received strong support from the experiments of one of the brightest of Rutherford's bright young men - Henry Moseley (1887-1915). Moseley came from a distinguished scientific family. Not only his father, but also both his grandfathers, had been elected to the Royal Society. After studying at Oxford, where his father had once been a professor, Moseley found it difficult to decide where to do his postgraduate work. Two laboratories attracted him: the great J.J. Thomson's Cavendish Laboratory at Cambridge, and Rutherford's laboratory at Manchester. Finally, he decided on Manchester, because of the revolutionary discoveries of Rutherford, who two years earlier had won the 1908 Nobel Prize for Chemistry.

Rutherford's laboratory was like no other in the world, except J.J. Thomson's. In fact, Rutherford had learned much about how to run a laboratory from his old teacher, Thomson. Rutherford continued Thomson's tradition of democratic informality and cheerfulness. Like Thomson, he had a gift for infecting his students with his own powerful scientific curiosity, and his enthusiastic enjoyment of research.

Thomson had also initiated a tradition for speed and ingenuity in the improvisation of experimental apparatus - the so-called "sealing-wax and string" tradition - and Rutherford continued it. Niels Bohr, after working with Rutherford, was later to continue the tradition of informality and enthusiasm at the Institute for Theoretical Physics which Bohr founded in Copenhagen in 1920.

Most scientific laboratories of the time offered a great contrast to the informality, enthusiasm, teamwork and speed of the Thomson-Rutherford-Bohr tradition. E.E. da C. Andrade, who first worked in Lenard's laboratory at Heidelberg, and later with Rutherford at Manchester, has given the following description of the contrast between the two groups:

"At the Heidelberg colloquium, Lenard took the chair, very much like a master with his class. He had the habit, if any aspect of his work was being treated by the speaker, of interrupting with, 'And who did that first?' The speaker would reply with a slight bow, 'Herr Geheimrat, you did that first', to which Lenard answered, 'Yes, I did that first'."

"At the Manchester colloquium, which met on Friday afternoons, Rutherford was, as in all his relations with the research workers, the boisterous, enthusiastic, inspiring friend, undoubtedly the leader but in close community with the led, stimulating rather than commanding, 'gingering up', to use a favourite expression of his, his team."

Although Rutherford occasionally swore at his "lads", his affection for them was very real. He had no son of his own, and he became a sort of father to the brilliant young men in his laboratory. Their nickname for him was "Papa". Such was the laboratory which Harry Moseley joined in 1910. At almost the same time, Moseley's childhood friend, Charles Darwin (the grandson of the "right" Charles Darwin), also joined Rutherford's team.

After working on a variety of problems in radioactivity which were given to him by Rutherford, Moseley asked whether he and Charles Darwin might be allowed to study the spectra of X-rays. At first, Rutherford said no, since no one at Manchester had any experience with X-rays; "and besides", Rutherford added with a certain amount of bias, "all science is either radioactivity or else stamp-collecting".

However, after looking more carefully at what was being discovered about X-rays, Rutherford gave his consent. In 1912, a revolutionary discovery had been made by the Munich physicist, Max von Laue (1879-1960): It had long been known that because of its wavelike nature, white light can be broken up into the colors of the spectrum by means of a "diffraction grating" - a series of parallel lines engraved very closely together on a glass plate.

For each wavelength of light, there are certain angles at which the new wavelets produced by the lines of the diffraction grating reinforce each other instead of cancelling. The angles of reinforcement are different for each wavelength, and thus the different colors are separated by the grating.

Max von Laue's great idea was to do the same thing with X-rays, using a crystal as a diffraction grating. The regular lines of atoms in the crystal, von Laue reasoned, would act be fine enough to fit the tiny wavelength of the X-rays, believed to be less than one ten-millionth of a centimeter.

Von Laue's experiment, performed in 1912, had succeeded beautifully, and his new technique had been taken up in England by a father and son team, William Henry Bragg (1862-1942) and William Lawrence Bragg (1890-1971). The Braggs had used X-ray diffraction not only to study the spectra of X-rays, but also to study the structure of crystals. Their techniques were later to become one of the most valuable research tools available for studying molecular structure.

Having finally obtained Rutherford's permission, Moseley and Darwin threw themselves into this exciting field of study. Remembering his work with Harry Moseley, Charles Darwin later wrote:

"Working with Moseley was one of the most strenuous exercises I have ever undertaken. He was, without exception, the hardest worker I have ever known... There were two rules for his work: First, when you started to set up the apparatus for an experiment, you must not stop until it was set up. Second, when the apparatus was set up, you must not stop work until the experiment was done. Obeying these rules implied a most irregular life, sometimes with all-night sessions; and indeed, one of Moseley's experteses was the knowledge of where in Manchester one could get a meal at three in the morning."

After about a year, Charles Darwin left the experiments to work on the theoretical aspects of X-ray diffraction. (He was later knighted for his distinguished contributions to theoretical physics.) Moseley continued the experiments alone, systematically studying the X-ray spectra of all the elements in the periodic system.

Niels Bohr had shown that the binding energies of the allowed orbits in a hydrogen atom are equal to Rydberg's constant , R (named after the distinguished Swedish spectroscopist, Johannes Robert Rydberg), divided by the square of an integral "quantum number", n. He had also shown that for heavier elements, the constant, R, is equal to the square of the nuclear charge, Z, multiplied by a factor which is the same for all elements. The constant, R, could be observed in Moseley's studies of X-ray spectra: Since X-rays are produced when electrons are knocked out of inner orbits and outer electrons fall in to replace them, Moseley could use the Planck-Einstein relationship between frequency and energy to find the energy difference between the orbits, and Bohr's theory to relate this to R.

Moseley found complete agreement with Bohr's theory. He also found that the nuclear charge, Z, increased regularly in integral steps as he went along the rows of the periodic table: Hydrogen had Z=1, helium Z=2, lithium Z=3, and so on up to uranium with Z=92. The 92 electrons of a uranium atom made it electrically neutral, exactly balancing the charge of the nucleus. The number of electrons of an element, and hence its chemical properties, Moseley found, were determined uniquely by its nuclear charge, which Moseley called the "atomic number".

Moseley's studies of the nuclear charges of the elements revealed that a few elements were missing. In 1922, Niels Bohr received the Nobel Prize for his quantum theory of the atom; and he was able to announce at the presentation ceremony that one of Moseley's missing elements had been found at his institute. Moseley, however, was dead. He was one of the ten million young men whose lives were needlessly thrown away in Europe's most tragic blunder - the First World War.

A wave equation for matter

In 1926, the difficulties surrounding the "old quantum theory" of Max Planck, Albert Einstein and Niels Bohr were suddenly solved, and its true meaning was understood. Two years earlier, a French aristocrat, Prince Louis de Broglie, writing his doctoral dissertation at the Sorbonne in Paris, had proposed that very small particles, such as electrons, might exhibit wavelike properties. The ground state and higher excited states of the electron in Bohr's model of the hydrogen atom would then be closely analogous to the fundamental tone and higher overtones of a violin string.

Almost the only person to take de Broglie's proposal seriously was Albert Einstein, who mentioned it in one of his papers. Because of Einstein's interest, de Broglie's matter-waves came to the attention of other physicists. The Austrian theoretician, Erwin Schrödinger, working at Zürich, searched for the underlying wave equation which de Broglie's matter-waves obeyed.

Schrödinger's gifts as a mathematician were so great that it did not take him long to solve the problem. The Schrödinger wave equation for matter is now considered to be more basic than Newton's equations of motion. The wavelike properties of matter are not apparent to us in our daily lives because the wave-lengths are extremely small in comparison with the sizes of objects which we can perceive. However, for very small and light particles, such as electrons moving in their orbits around the nucleus of an atom, the wavelike behavior becomes important.

Schrödinger was able to show that Niels Bohr's atomic theory, including Bohr's seemingly arbitrary quantization of angular momentum, can be derived by solving the wave equation for the electrons moving in the attractive field of the nucleus. The allowed orbits of Bohr's theory correspond in Schrödinger's theory to harmonics, similar to the fundamental harmonic and higher overtones of an organ pipe or a violin string. (If Pythagoras had been living in 1926, he would have rejoiced to see the deepest mysteries of matter explained in terms of harmonics!)

Bohr himself believed that a complete atomic theory ought to be able to explain the chemical properties of the elements in Mendeléev's periodic system. Bohr's 1913 theory failed to pass this test, but the new de Broglie-Schrödinger theory succeeded! Through the work of Pauli, Heitler, London, Slater, Pauling, Hund, Mulliken, Hückel and others, who applied Schrödinger's wave equation to the solution of chemical problems, it became apparent that the wave equation could indeed (in principle) explain all the chemical properties of matter.

Strangely, the problem of developing the fundamental quantum theory of matter was solved not once, but three times in 1926! At the University of Göttingen in Germany, Max Born (1882-1970) and his brilliant young students Werner Heisenberg and Pascal Jordan solved the problem in a completely different way, using matrix methods. At the same time, a theory similar to the "matrix mechanics" of Heisenberg, Born and Jordan was developed independently at Cambridge University by a 24 year old mathematical genius named

Figure 1.9: *Bust of Erwin Schrödinger in the courtyard arcade of the main building, University of Vienna. Daderot at the English Language Wikipedia, [CC BY-SA 3.0], Wikimedia Commons*

Paul Adrien Maurice Dirac. At first, the Heisenberg-Born-Jordan-Dirac quantum theory seemed to be completely different from the Schrödinger theory; but soon the Göttingen mathematician David Hilbert (1862-1943) was able to show that the theories were really identical, although very differently expressed.

Suggestions for further reading

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Chapter 2

RELATIVITY

Einstein

Albert Einstein was born in Ulm, Germany, in 1879. He was the son of middle-class, irreligious Jewish parents, who sent him to a Catholic school. Einstein was slow in learning to speak, and at first his parents feared that he might be retarded; but by the time he was eight, his grandfather could say in a letter:

"Dear Albert has been back in school for a week. I just love that boy, because you cannot imagine how good and intelligent he has become."

Remembering his boyhood, Einstein himself later wrote:

"When I was 12, a little book dealing with Euclidian plane geometry came into my hands at the beginning of the school year. Here were assertions, as for example the intersection of the altitudes of a triangle in one point, which - though by no means self-evident - could nevertheless be proved with such certainty that any doubt appeared to be out of the question. The lucidity and certainty made an indescribable impression on me."

When Albert Einstein was in his teens, the factory owned by his father and uncle began to encounter hard times. The two Einstein families moved to Italy, leaving Albert alone and miserable in Munich, where he was supposed to finish his course at the gymnasium. Einstein's classmates had given him the nickname "Beidermeier", which means something like "Honest John"; and his tactlessness in criticizing authority soon got him into trouble. In Einstein's words, what happened next was the following:

"When I was in the seventh grade at the Lutpold Gymnasium, I was summoned by my home-room teacher, who expressed the wish that I leave the school. To my remark that I had done nothing wrong, he replied only, 'Your mere presence spoils the respect of the class for me'."

Einstein left gymnasium without graduating, and followed his parents to Italy, where he spent a joyous and carefree year. He also decided to change his

Figure 2.1: *Albert Einstein at the age of three years. This is believed to be the oldest known photograph of Einstein. Public domain, Wikimedia Commons*

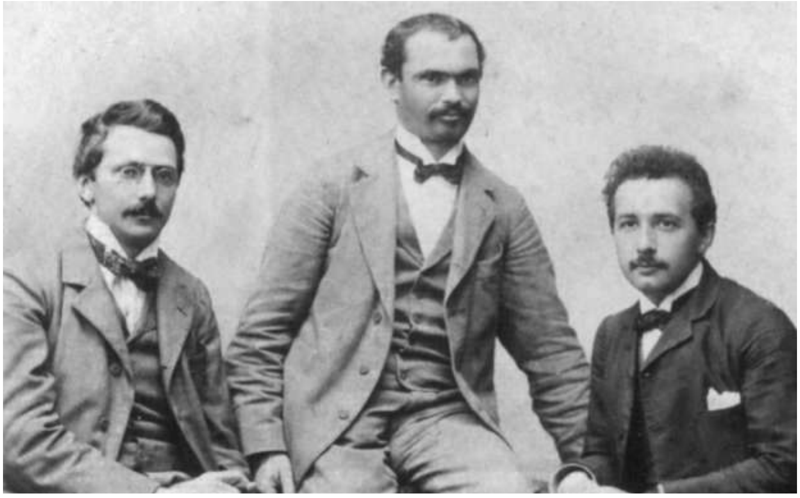

Figure 2.2: *Albert Einstein with Zürich friends Habicht and Solovine, ca. 1903. They met informally to discuss physics, calling themselves the "Olympia Academy". Public domain, Wikimedia Commons*

citizenship. "The over-emphasized military mentality of the German State was alien to me, even as a boy", Einstein wrote later. "When my father moved to Italy, he took steps, at my request, to have me released from German citizenship, because I wanted to be a Swiss citizen."

The financial circumstances of the Einstein family were now precarious, and it was clear that Albert would have to think seriously about a practical career. In 1896, he entered the famous Zürich Polytechnic Institute with the intention of becoming a teacher of mathematics and physics. However, his undisciplined and nonconformist attitudes again got him into trouble. His mathematics professor, Hermann Minkowski (1864-1909), considered Einstein to be a "lazy dog"; and his physics professor, Heinrich Weber, who originally had gone out of his way to help Einstein, said to him in anger and exasperation: "You're a clever fellow, but you have one fault: You won't let anyone tell you a thing! You won't let anyone tell you a thing!"

Einstein missed most of his classes, and read only the subjects which interested him. He was interested most of all in Maxwell's theory of electromagnetism, a subject which was too "modern" for Weber. There were two major examinations at the Zürich Polytechnic Institute, and Einstein would certainly have failed them had it not been for the help of his loyal friend, the mathematician Marcel Grossman.

Grossman was an excellent and conscientious student, who attended every class and took meticulous notes. With the help of these notes, Einstein managed to pass his examinations; but because he had alienated Weber and the other professors who could have helped him, he found himself completely unable to get a job. In a letter to Professor F. Ostwald on behalf of his son, Einstein's father wrote: "My son is profoundly unhappy because of his present joblessness; and every day the idea becomes more firmly implanted in his mind that he is a failure, and will not be able to find the way back again."

From this painful situation, Einstein was rescued (again!) by his friend Marcel Grossman, whose influential father obtained for Einstein a position at the Swiss Patent Office - Technical Expert (Third Class). Anchored at last in a safe, though humble, position, Einstein married one of his classmates, a Serbian girl named Mileva Maric. He learned to do his work at the Patent Office very efficiently; and he used the remainder of his time on his own calculations, hiding them guiltily in a drawer when footsteps approached.

Special relativity

In 1905, this Technical Expert (Third Class) astonished the world of science with five papers, written within a few weeks of each other, and published in the *Annalen der Physik*. Of these five papers, three were classics: One of these was the paper in which Einstein applied Planck's quantum hypothesis to the photoelectric effect. The second paper discussed "Brownian motion", the zig-zag motion of small particles suspended in a liquid and hit randomly by the molecules of the liquid. This paper supplied a direct proof of the validity of atomic ideas and of Boltzmann's kinetic theory.

The third paper was destined to establish Einstein's reputation as one of the greatest physicists of all time. It was entitled *On the Electrodynamics of Moving Bodies*, and in this paper, Albert Einstein formulated his special theory of relativity.

The theory of relativity grew out of problems connected with Maxwell's electromagnetic theory of light. Ever since the wavelike nature of light had first been demonstrated, it had been supposed that there must be some medium to carry the light waves, just as there must be some medium (for example air) to carry sound waves. A word was even invented for the medium which was supposed to carry electromagnetic waves: It was called the "ether".

By analogy with sound, it was believed that the velocity of light would depend on the velocity of the observer relative to the "ether". However, all attempts to measure differences in the velocity of light in different directions had failed, including an especially sensitive experiment which was performed in America in 1887 by A.A. Michelson and E.W. Morley.

Even if the earth had, by a coincidence, been stationary with respect to the "ether" when Michelson and Morley first performed their experiment, they should have found an "ether wind" when they repeated their experiment half a year later, with the earth at the other side of its orbit. Strangely, the observed velocity of light seemed to be completely independent of the motion of the observer!

In his famous 1905 paper on relativity, Einstein made the negative result of the Michelson-Morley experiment the basis of a far-reaching principle: He asserted that no experiment whatever can tell us whether we are at rest or whether we are in a state of uniform motion. With this assumption, the Michelson-Morley experiment of course had to fail, and the measured velocity of light had to be independent of the motion of the observer.

Einstein's Principle of Special Relativity had other extremely important consequences: He soon saw that if his principle were to hold, then Newtonian mechanics would have to be modified. In fact, Einstein's Principle of Special Relativity required that *all* fundamental physical laws exhibit a symmetry between space and time. The three space dimensions, and a fourth dimension, ict, had to enter every fundamental physical law in a symmetrical way. (Here i is the square root of -1, c is the velocity of light, and t is time.)

When this symmetry requirement is fulfilled, a physical law is said to be "Lorentz-invariant" (in honor of the Dutch physicist H.A. Lorentz, who anticipated some of Einstein's ideas). Today, we would express Einstein's principle by saying that every fundamental physical law must be Lorentz-invariant (i.e. symmetrical in the space and time coordinates). The law will then be independent of the motion of the observer, provided that the observer is moving uniformly.

Einstein was able to show that, when properly expressed, Maxwell's equations are already Lorentz-invariant; but Newton's equations of motion have to be modified. When the needed modifications are made, Einstein found, then the mass of a moving particle appears to increase as it is accelerated. A particle can never be accelerated to a velocity greater than the velocity of light; it merely becomes heavier and heavier, the added energy being converted into mass.

From his 1905 theory, Einstein deduced his famous formula equating the energy of a system to its mass multiplied by the square of the velocity of light. As we shall see, his formula was soon used to explain the source of the energy produced by decaying uranium and radium; and eventually it led to the construction of the atomic bomb. Thus Einstein, a lifelong pacifist, who renounced his German citizenship as a protest against militarism, became instrumental in the construction of the most destructive weapon ever invented - a weapon which casts an ominous shadow over the future of humankind.

Just as Einstein was one of the first to take Planck's quantum hypothesis seriously, so Planck was one of the first physicists to take Einstein's relativity seriously. Another early enthusiast for relativity was Hermann Minkowski, Einstein's former professor of mathematics. Although he once had characterized Einstein as a "lazy dog", Minkowski now contributed importantly to the mathematical formalism of Einstein's theory; and in 1907, he published the first book on relativity. In honor of Minkowski's contributions to relativity, the 4-dimensional space-time continuum in which we live is sometimes called "Minkowski space".

In 1908, Minkowski began a lecture to the Eightieth Congress of German Scientists and Physicians with the following words:

" From now on, space by itself, and time by itself, are destined to sink completely into the shadows; and only a kind of union of both will retain an independent existence."

General relativity

Gradually, the importance of Einstein's work began to be realized, and he was much sought after. He was first made Assistant Professor at the University of Zürich, then full Professor in Prague, then Professor at the Zürich Polytechnic Institute; and finally, in 1913, Planck and Nernst persuaded Einstein to become Director of Scientific Research at the Kaiser Wilhelm Institute in Berlin. He was at this post when the First World War broke out.

While many other German intellectuals produced manifestos justifying Germany's invasion of Belgium, Einstein dared to write and sign an anti-war manifesto. Einstein's manifesto appealed for cooperation and understanding among the scholars of Europe for the sake of the future; and it proposed the eventual establishment of a League of Europeans. During the war, Einstein remained in Berlin, doing whatever he could for the cause of peace, burying himself unhappily in his work, and trying to forget the agony of Europe, whose civilization was dying in a rain of shells, machine-gun bullets, and poison gas.

The work into which Einstein threw himself during this period was an extension of his theory of relativity. He already had modified Newton's equations of motion so that they exhibited the space-time symmetry required by his Principle of Special Relativity. However, Newton's law of gravitation remained a problem. Obviously it had to be modified, since it was not Lorentz-invariant; but how should it be changed?

What principles could Einstein use in his search for a more correct law of gravitation? Certainly whatever new law he found would have to give results very close to Newton's law, since Newton's theory could predict the motions of the planets with almost perfect accuracy. This was the deep problem with which he struggled.

In 1907, Einstein had found one of the principles which was to guide him - the Principle of Equivalence of inertial and gravitational mass. After turning Newton's theory over and over in his mind, Einstein realized that Newton had used mass in two distinct ways: His laws of motion stated that the force acting on a body is equal to the mass of the body multiplied by its acceleration; but according to Newton, the gravitational force on a body is also proportional to its mass.

In Newton's theory, gravitational mass, by a coincidence, is equal to inertial mass; and this holds for all bodies. Einstein wondered - can the equality between the two kinds of mass be a coincidence? Why not make a theory in which they necessarily have to be the same?

He then imagined an experimenter inside a box, unable to see anything outside it. If the box is on the surface of the earth, the person inside it will feel the pull of the earth's gravitational field. If the experimenter drops an object, it will fall to the floor with an acceleration of 32 feet per second per second. Now suppose that the box is taken out into empty space, far away from strong gravitational fields, and accelerated by exactly 32 feet per second per second. Will the enclosed experimenter be able to tell the difference between these two situations? Certainly no difference can be detected by dropping an object, since in the accelerated box, the object will fall to the floor in exactly the same way as before.

With this "thought experiment" in mind, Einstein formulated a general Principle of Equivalence: He asserted that no experiment whatever can tell an observer enclosed in a small box whether the box is being accelerated, or whether it is in a gravitational field. According to this principle, gravitation and acceleration are locally equivalent, or, to say the same thing in different words, gravitational mass and inertial mass are equivalent.

Einstein soon realized that his Principle of Equivalence implied that a ray of light must be bent by a gravitational field. This conclusion followed because, to an observer in an accelerated frame, a light beam which would appear straight to a stationary observer, must necessarily appear very slightly curved. If the Principle of Equivalence held, then the same slight bending of the light ray would be observed by an experimenter in a stationary frame in a gravitational field.

Another consequence of the Principle of Equivalence was that a light wave propagating upwards in a gravitational field should be very slightly shifted to the red. This followed because in an accelerated frame, the wave crests would be slightly farther apart than they normally would be, and the same must then be true for a stationary frame in a gravitational field. It seemed to Einstein that it ought to be possible to test experimentally both the gravitational bending of a light ray and the gravitational red shift.

Figure 2.3: *Albert Einstein and his first wife, his classmate Mileva Maric. Public domain, Wikimedia Commons*

This seemed promising; but how was Einstein to proceed from the Principle of Equivalence to a Lorentz-invariant formulation of the law of gravitation? Perhaps the theory ought to be modeled after Maxwell's electromagnetic theory, which was a field theory, rather than an "action at a distance" theory. Part of the trouble with Newton's law of gravitation was that it allowed a signal to be propagated instantaneously, contrary to the Principle of Special Relativity. A field theory of gravitation might cure this defect, but how was Einstein to find such a theory? There seemed to be no way.

From these troubles Albert Einstein was rescued (a third time!) by his staunch friend Marcel Grossman. By this time, Grossman had become a professor of mathematics in Zürich, after having written a doctoral dissertation on tensor analysis and non-Euclidian geometry - the very things that Einstein needed. The year was 1912, and Einstein had just returned to Zürich as Professor of Physics at the Polytechnic Institute. For two years, Einstein and Grossman worked together; and by the time Einstein left for Berlin in 1914, the way was clear.

With Grossman's help, Einstein saw that the gravitational field could be expressed as a curvature of the 4-dimensional space-time continuum. The mathematical methods appropriate for describing the curvature of a many-dimensional space had already been developed in the early 19th century by Nickolai Ivanovich Lobachevski (1793-1856), Karl Friedrich Gauss (1777-1855) and Bernard Riemann (1826-1866).

As an example of a curved space, we might think of the 2-dimensional space formed by the surface of a sphere. The geometry of figures drawn on a sphere is non-Euclidian: Parallel lines meet, and the angles of a triangle add up to more than 180 degrees. Non-Euclidian spaces of higher dimension are hard to visualize, but they can be treated mathematically.

Gauss and Riemann had introduced a "metric tensor" which contained all the necessary information about the curvature of a non-Euclidian space; and Einstein saw that this metric tensor could be used to express the gravitational field. The orbits of the planets became "geodesics" in curved space. A geodesic is the shortest distance between two points, but in the curved space-time continuum of Einstein's theory, the geodesics were not straight lines.

By 1915, working by himself in Berlin, Einstein was able to show that the simplest theory of this form yielded Newton's law of gravitation as a first approximation, and in a higher approximation, it gave the correct movement of the perihelion of the orbit of Mercury. It had long been known that Mercury's point of closest approach to the sun (its perihelion) drifted slowly forward at the rate of between 40 and 50 seconds of arc per century. Einstein calculated that the change of Mercury's perihelion each century should be 43 seconds of arc. In January, 1916, he wrote to his friend Paul Ehrenfest:

"Imagine my joy at the feasibility of the general covariance, and at the result that the equations yield the correct perihelion of mercury. I was beside myself with ecstasy for days."

In 1919, a British expedition, headed by Sir Arthur Eddington, sailed to a small island off the coast of West Africa. Their purpose was to test Einstein's prediction of the bending of light in a gravitational field by observing stars close to the sun during a total eclipse. The observed bending agreed exactly with Einstein's predictions; and as a result he became world-famous.

The general public was fascinated by relativity, in spite of the abstruseness of the theory (or perhaps because of it). Einstein, the absent-minded professor, with long, uncombed hair, became a symbol of science. The world was tired of war, and wanted something else to think about.

Einstein met President Harding, Winston Churchill and Charlie Chaplin; and he was invited to lunch by the Archbishop of Canterbury. Although adulated elsewhere, he was soon attacked in Germany. Many Germans, looking for an excuse for the defeat of their nation, blamed it on the pacifists and Jews; and Einstein was both these things.

Albert Einstein's famous relativistic formula, relating energy to mass, soon yielded an understanding of the enormous amounts of energy released in radioactive decay. Marie and Pierre Curie had noticed that radium maintains itself at a temperature higher than its surroundings. Their measurements and calculations showed that a gram of radium produces roughly 100 gram-calories of heat per hour.

This did not seem like much energy until Rutherford found that radium has a half-life of about 1,000 years. In other words, after a thousand years, a gram of radium will still be producing heat, its radioactivity only reduced to one-half its original value. During a thousand years, a gram of radium produces about a million kilocalories - an enormous amount of energy in relation to the tiny size of its source! Where did this huge amount of energy come from? Conservation of energy was one of the most basic principles of physics. Would it have to be abandoned?

The mass defect

The source of the almost-unbelievable amounts of energy released in radioactive decay could be understood through Einstein's formula equating the energy of a system to its mass multiplied by the square of the velocity of light, and through accurate measurements of atomic weights. Einstein's formula asserted that mass and energy are equivalent. It was realized that in radioactive decay, neither mass nor energy is conserved, but only a quantity more general than both, of which mass and energy are particular forms.

The quantitative verification of the equivalence of mass and energy depended on very accurate measurements of atomic weights. Until 1912, the atomic weights of the elements were a puzzle. For some elements, the weights were very nearly integral multiples of the atomic weight of hydrogen, in units of which carbon was found to have an atomic weight almost exactly equal to 12, while nitrogen, oxygen and sodium were respectively 14, 16 and 23. This almost exact numerical correspondence made the English chemist, William Prout (1785-1850), propose that hydrogen might be the fundamental building-block of nature, and that atoms of all elements might be built up out of hydrogen.

Prout's hypothesis was destined to be killed several times, and revived several times. It was soon discovered that many elements have atomic weights which are not even nearly integral multiples of the weight of hydrogen. This discovery killed Prout's hypothesis for the first time. However, through their studies of radioactive decay, Rutherford and Soddy discovered isotopes; and isotopes revived Prout's hypothesis.

Rutherford and Soddy demonstrated that in the decay of uranium to its final product, lead, a whole chain of intermediates is involved, all of them radioactive, and each one changing spontaneously to the next. But what elements could these intermediate links of the decay chain be? After all, among the known elements, only uranium, polonium, radium, actinium and thorium were radioactive - and one could show that these elements could not represent all the intermediates of the Rutherford-Soddy decay chain.

In 1912, in Rutherford's Manchester laboratory, a young chemist named

Figure 2.4: *Together with Rutherford, Frederick Soddy received the Nobel Prize in Chemistry in 1921 for the discovery of isotopes. Public domain, Wikimedia Commons*

Georg von Hevesy was trying to separate by chemical means two radioactive decay products known to be different from each other because their half-lives were different. But no matter what he tried, von Hevesy could not separate them. All chemical methods failed.

Hevesy discussed his troubles with Niels Bohr, who suggested that the two decay products might be atoms with the same nuclear charges, but different atomic weights. Since the number of electrons was determined by the nuclear charge, and since the chemical properties were determined by the number of electrons, it would be impossible to separate the two decay products by chemical means. They were, in fact, different varieties of the same element.

The same idea occurred simultaneously and independently to Frederick Soddy. In the autumn of 1912, he published a detailed paper explaining the concept, and introducing the word "isotope". Each chemical element, Soddy explained, is a mixture of isotopes. For those elements whose atomic weight is nearly an integral multiple of the atomic weight of hydrogen, a single isotope dominates the mixture. All the isotopes of a given element have the same nuclear charge (atomic number) and the same number of electrons; but two different isotopes of the same element have different atomic weights and different nuclear properties, some isotopes being radioactive, while others are stable.

When a nucleus emits a beta-particle (a high-speed electron carrying one unit of negative charge, but very little mass), the weight of the nucleus is almost unchanged, but its charge increases by one unit. Therefore beta-decay produces a product which is one place higher in the periodic table than its parent.

In alpha-decay, on the other hand, a helium ion, with two units of positive charge, and four units of mass, is thrown out of the decaying nucleus. Therefore, in alpha-decay, the product is two places lower in the periodic table, and four atomic mass units lighter than the parent atom.

The concept of isotopes allowed Frederick Soddy to identify clearly all the intermediate links in the decay chains which he and Rutherford had studied; and he later received the Nobel Prize in Chemistry for his work. Georg von Hevesy became the first scientist to use radioactive isotopes as tracers in biochemistry; and he also received the Nobel Prize in Chemistry.

Meanwhile, at the Cavendish Laboratory in Cambridge, J.J. Thomson and his student, Francis Aston (1877-1945), developed a "mass-spectrograph" - an instrument which could separate isotopes from one another by accelerating them with both electric and magnetic fields. In Aston's hands, the mass spectrograph became a precision instrument. Using it, he could not only separate isotopes from one another - he could also measure their masses very accurately. He found these masses to be almost exactly integral multiples of the mass of a hydrogen atom, but not quite! There was always a little mass missing!

The explanation for the missing mass - the mass defect - was found through Prout's hypothesis (newly revived) and Einstein's formula relating mass to energy. The nucleus of an atom was visualized as being composed of hydrogen nuclei (protons) and electrons bound tightly together. The mass defect, through Einstein's formula, was equivalent to the energy which would be needed to separate these elementary particles.

By observing the mass defects of isotopes, one could calculate their binding energies; and from these, the vast amounts of energy available for release through nuclear transmutation could also be calculated. For the first time, humans realized the enormous power which was potentially available in the atomic nucleus.

Suggestions for further reading

1. Paul Arthur Schlipp (editor), *Albert Einstein: Philosopher-Scientist*, Open Court Publishing Co., Lasalle Illinois (1970).
2. Banesh Hoffmann, *Albert Einstein, Creator and Rebel*, The Viking Press, New York (1972).
3. Albert Einstein and Leopold Infeld, *The Evolution of Physics*, Cambridge University Press (1971).

Chapter 3

NUCLEAR FISSION

Artificial transmutations

During the First World War, Rutherford's young men had joined the army, and he had been forced to spend most of his own time working on submarine detection. In spite of this, he had found some spare time for his scientific passion - bombarding matter with alpha particles. Helped by his laboratory steward, Kay, Rutherford had studied the effects produced when alpha particles from a radium source struck various elements. In a letter to Niels Bohr, dated December 9, 1917, Rutherford wrote:

"I have got, I think, results that will ultimately have great importance. I wish that you were here to talk matters over with me. I am detecting and counting the lighter atoms set in motion by alpha particles, and the results, I think, throw a good deal of light on the character and distribution of forces near the nucleus... I am trying to break up the atom by this method. In one case, the results look promising, but a great deal of work will be required to make sure. Kay helps me, and is now an expert counter. Best wishes for a happy Christmas."

In July, 1919, Bohr was at last able to visit Manchester, and he heard the news directly from his old teacher: Rutherford had indeed produced artificial nuclear transmutations! In one of his experiments, an alpha-particle (i.e. a helium nucleus with nuclear charge 2) was absorbed by a nitrogen nucleus. Later, the compound nucleus threw out a proton with charge 1; and thus the bombarded nucleus gained one unit of charge. It moved up one place in the periodic table and became an isotope of oxygen.

Bohr later wrote: "I learned in detail about his great new discovery of controlled, or so-called artificial, nuclear transmutations, by which he gave birth to what he liked to call 'modern Alchemy', and which in the course of time, was to give rise to such tremendous consequences as regards man's mastery of the forces of nature."

Other scientists rushed to repeat and extend Rutherford's experiments. Particle accelerators were built by E.O. Lawrence (1901-1958) in California, by J.H. van de Graff (1901-1967) at the Massachusetts Institute of Technology and by John Cockcroft (1897-1967), working with Rutherford at the Cavendish Laboratory. These accelerators could hurl protons at energies of a million electron-volts. Thus, protons became another type of projectile which could be used to produce nuclear transmutations.

Neutrons

During the 1920's, nuclear transmutations could be achieved only with light elements. The charges on the nuclei of heavy elements were so large that, with the energies available, alpha particles and protons could not react with them. The positively charged projectiles were kept at a distance by the electrostatic repulsion of the heavy nuclei: They could not come close enough for the powerful but short-range nuclear attractive forces to become effective. However, in 1932, a new projectile was discovered - a projectile which was destined to unlock, with grave consequences, the colossal energies of the heavy nuclei. This new projectile was the neutron.

Rutherford and Bohr had for some time suspected that an electrically neutral particle with roughly the same mass as a proton might exist. The evidence for such a particle was as follows: Each isotope was characterized by a nuclear charge and by a nuclear weight. The nuclear charge was an integral multiple of the proton charge, while the nuclear weight was approximately an integral multiple of the proton weight. For example, the isotope carbon-12 had charge 6 and weight 12. This might be explained by supposing the carbon-12 nucleus to be composed of twelve protons and six electrons. However, there were theoretical objections to a model in which many electrons were concentrated within the tiny volume of a nucleus. Therefore, in 1920, Rutherford postulated the existence of neutrons - elementary particles with almost the same mass as protons, but no electrical charge. Then (for example) the carbon-12 nucleus could be thought of as being composed of six protons and six neutrons.

In 1930, the German physicist, Walter Bothe (1891-1957), discovered a strange, penetrating type of radiation coming from beryllium which had been bombarded with alpha particles. In 1931 and 1932, Bothe's experiments were repeated in Paris by Irène Joliot-Curie (1897-1956) and her husband Frédéric (1900-1958). The Joliot-Curies noticed that the mysterious rays emanating from the bombarded beryllium could easily penetrate lead. They also noticed that when the rays hit a piece of paraffin, hydrogen nuclei were knocked out.

Figure 3.1: *Irène Joliot-Curie as a child, with her parents, Pierre and Marie Curie. Although she and her husband Frèdèric narrowly missed discovering the neutron, they soon made another discovery of major importance - artificial radioactivity. Public domain, Wikimedia Commons*

The strange rays were, in fact, neutrons, as the Joliot-Curies would have realized immediately if they had been familiar with Rutherford's prediction of the neutron's existence. The Joliot-Curies might have made the correct identification of the rays given time; but Rutherford's assistant, James Chadwick (1891-1974), was faster. On February 17, 1932, he published a paper in *Nature* reporting a series of experiments:

Chadwick had studied not only the velocities of the hydrogen nuclei knocked out of paraffin by Bothe's rays but also the velocities of nuclei knocked out of many other materials. In every case, he found that the velocities were consistent with the identification of the rays as neutrons. Chadwick completed his proof by showing that the rays moved with one-tenth the velocity of light, so that they had to be material particles rather than radiation; and he showed that the rays could not be deflected by a magnet. Therefore they carried no charge.

Fermi

Although Irène and Frédéric Joliot-Curie narrowly missed discovering the neutron, they soon made another discovery of major importance - artificial radioactivity. The Joliot-Curies had been bombarding an aluminum target with alpha-particles and studying the resulting radiation. One day in 1934, they noticed to their astonishment that the aluminum target continued to radiate even after they had stopped the alpha-particle bombardment. They discovered that some of the aluminum atoms in the target had been converted to a radioactive isotope of phosphorus!

In 1934, news of the startling discoveries of Bothe, Chadwick and the Joliot-Curies reached a brilliant young professor of theoretical physics in Rome. Although he was only 33 years old, Enrico Fermi (1901-1954) already had a worldwide reputation for his work in quantum theory. He also had attracted a school of extremely talented young students, the first physicists in Italy to enter the new fields of quantum mechanics and relativity: Persico, Amaldi, Rasetti, Segrè, Pontecorvo, Majorana, Racah and Wick. It was a happy, informal group of young men.

Because of his reputation for scientific infallibility, Enrico Fermi was nicknamed "the Pope", while Franco Rasetti was "the Cardinal" and Emilio Segrè was "the Basilisk". A medical colleague, Professor Trabacci, who generously supplied the group with equipment and chemicals, was known as "the Divine Providence".

In 1934, Fermi was feeling somewhat discouraged with theoretical work, and in the mood to try something new. His paper on the theory of beta-decay (later regarded as one of his major achievements) had just been rejected by *Nature.* At that moment, he heard of Chadwick's neutrons and the Joliot-Curie's artificial radioactivity. Putting the two things together, Fermi decided to try to produce artificial radioactivity by bombarding elements with neutrons.

There were good theoretical reasons why Fermi's plan should work, as well as practical reasons why it should fail. The argument in favor of neutrons was that they had no charge. Therefore they should be able to approach the nuclei of even heavy elements without being repelled by the electrostatic potential. The practical argument against neutrons was that it was difficult to produce them in worthwhile numbers. The yield of neutrons was only one for every hundred thousand alpha-particles.

Although he had no experience in working with radioactivity, Fermi managed to make his own Geiger counter. He also made a neutron source for himself by condensing radon gas (donated by "the Divine Providence") into a small glass tube of powdered beryllium held at liquid air temperature.

Being a methodical person, Fermi began at the bottom of the periodic table and worked systematically upwards. The first eight elements which he bombarded with neutrons showed no artificial radioactivity, and Fermi almost became discouraged. Finally, he came to fluorine, and to his delight, he succeeded in making it strongly radioactive by neutron bombardment. He succeeded also with several other elements beyond fluorine; and realizing that the line of research was going to be very fruitful, he enlisted help from Segrè, Amaldi, and the chemist, d'Agostino. Fermi also sent a cable to Franco Rasetti, who was on vacation in Marocco.

In order that the source should not disturb the measurements, the room where the elements were irradiated was far from the room where their radioactivity was measured - at the other end of a long corridor. The half-life of the induced radioactivity was very short in some elements, which meant that Fermi and Amaldi had to run full tilt with their samples, from one end of the hallway to the other.

One day a visitor arrived from Spain and asked to see *"Sua Eccellenza Fermi"*. (Fermi was a member of the Royal Academy of Italy, and therefore had the title "Excellency", which much embarrassed him). "The Pope is upstairs", said Segrè, and then, realizing that the visitor did not know this nickname, he added: "I mean Fermi, of course." The Spanish visitor arrived on the second floor of the institute just in time to see *"Sua Eccellenza Fermi"* dash wildly down the length of the corridor.

After this fashion, Fermi and his group finally reached the top of the periodic table. They carefully purified uranium from its disintegration products and bombarded it with neutrons. A new radioactivity was induced, quite different from the ordinary activity of uranium. The question was: to what element or elements had the uranium been converted?

With the help of the chemist, d'Agostino, they analysed the uranium target, and proved definitely that neutron bombardment had not converted uranium to any of the nearby heavy elements at the top of the periodic table. It seemed most likely that what they had produced by bombarding uranium was a new, unstable element, which had never before existed - element number 93! However, they lacked definite proof; and Fermi, always cautious, refused to jump to such a sensational conclusion.

By this time, the summer of 1934 had begun. The university year ended, as was traditional, with a meeting of the Accademia dei Lincei, attended by the King of Italy. In 1934, the speaker at this meeting was Senator Corbino, who had been a talented physicist before he became a politician. Corbino had been responsible for raising money to support Fermi's group of young physicists; and he was justly proud of what they had achieved. In his 1934 speech before the king, Senator Corbino glowingly described their production of neutron-induced radioactivity; and he ended the speech with the words:

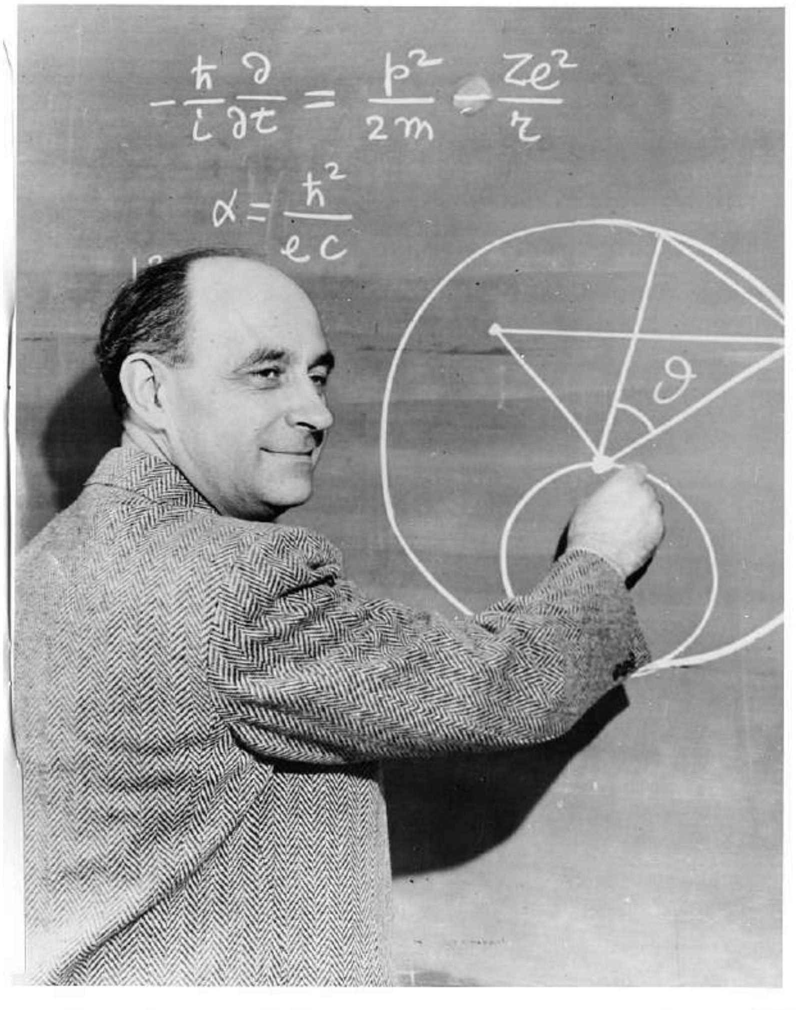

Figure 3.2: *Enrico Fermi at the blackboard. Public domain, Wikimedia Commons*

"The case of uranium, atomic number 92, is particularly interesting. It seems that, having absorbed the neutron, it converts rapidly by emission of an electron, into the element one place higher in the periodic system, that is, into a new element having atomic number 93... However, the investigation is so delicate that it justifies Fermi's prudent reserve and a continuation of the experiments before an announcement of the discovery. For what my own opinion on this matter is worth, and I have followed the investigations daily, I believe that production of this new element is certain."

Corbino had not cleared this announcement with Fermi. It was immediately picked up by both the Italian and international press and given great publicity. A new element had been made by man! The official newspapers of fascist Italy, in particular, made much of this "great discovery" which, they claimed, showed that Italy was regaining the glorious position which it had held in the days of the Roman Empire.

Fermi was thrown into a mood of deep despair by this premature publicity. He could not sleep, and woke his wife in the middle of the night to tell her that his reputation as a scientist was in jeopardy. Next morning, Fermi and Corbino prepared a statement attempting to halt the publicity: "The public is giving an incorrect interpretation to Senator Corbino's speech... Numerous and delicate tests must still be performed before the production of element 93 is actually proved."

Before the question of element 93 could be cleared up, the attention of Fermi's group was distracted by an accidental discovery of extreme importance. They had been obtaining inconsistent and inexplicable results. The radioactivity induced in a sample depended in what seemed to be a completely illogical way on the conditions under which the experiment was performed. For example, if the target was bombarded with neutrons while standing on a wooden table, the induced activity was much stronger than when the target was on a marble table.

Fermi suspected that these strange results were due to scattering of neutrons by surrounding objects. He prepared a lead wedge to insert between neutron source and the counter to measure the scattering. However, he did not use the lead wedge which he had so carefully prepared.

"I was clearly dissatisfied with something", Fermi remembered later, "I tried every excuse to postpone putting the piece of lead in its place. I said to myself, 'No, I do not want this piece of lead here; what I want is a piece of paraffin.' It was just like that, with no advance warning, no prior reasoning. I immediately took some odd piece of paraffin and placed it where the piece of lead was to have been."

The effect of the paraffin was amazing. The radioactivity increased a hundredfold! Puzzled, the group adjourned for lunch and siesta. When they re-assembled a few hours later, Fermi had developed a theory to explain what was happening: The neutrons had almost the same mass as the hydrogen atoms in the paraffin. When they collided with the hydrogen atoms, the neutrons lost almost all their energy of motion, just as a billiard ball loses almost all its speed when it collides with another ball of equal mass. What Fermi and the others had discovered by accident was that slow neutrons are much more effective than fast ones in producing nuclear reactions.

"What we need", said Fermi, "is a large amount of water." The group excitedly took the neutron source and targets to Senator Corbino's nearby garden, where there was a goldfish pond. The hydrogen-containing water of the pond produced the same result: It slowed the neutrons, and greatly enhanced their effect.

That evening, at Edouardo Amaldi's house, they prepared a paper reporting their discovery. Fermi dictated, while Segrè wrote. Meanwhile, Rasetti, Amaldi and Pontecorvo walked up and down, all offering suggestions simultaneously. They made so much noise that when they left, the maid asked Mrs. Amaldi whether her guests had been drunk.

The happy and carefree days of the little group of physicists in Rome were coming to an end. They had thought that they could isolate themselves from politics; but in 1935, it became clear that this was impossible.

One day, in 1935, Segrè said to Fermi: "You are the Pope, and full of wisdom. Can you tell me why we are now accomplishing less than a year ago?"

Fermi answered without hesitation: "Go to the physics library. Pull out the big atlas that is there. Open it. You shall find your explanation." When Segrè did this, the atlas opened automatically to a much-thumbed map of Ethiopia.

In 1935, Mussolini's government had attacked Ethiopia, and Italy had been condemned by the League of Nations. For thinking Italians, this shock revealed the true nature of Mussolini's government. They could no longer ignore politics. Within a few years, Enrico Fermi and most of his group had decided that they could no longer live under the fascist government of Italy. By 1939, most of them were refugees in the United States.

Hahn, Meitner and Frisch

Without knowing it, Enrico Fermi and his group had split the uranium atom; but four years were to pass before this became apparent. All the experts agreed that Fermi's group had undoubtedly produced transuranic elements. There was only one dissenting voice - that of the German chemist, Ida Noddack, who was an expert in the chemistry of rare elements. Knowing no nuclear physics, but a great deal of chemistry, Ida Noddack saw the problem from a different angle; and in 1934 she wrote:

"It would be possible to assume that when a nucleus is demolished in this novel way by neutrons, nuclear reactions occur which may differ considerably from those hitherto observed in the effects produced on atomic nuclei by protons and alpha rays. It would be conceivable that when heavy nuclei are bombarded with neutrons, the nuclei in question might break into a number of larger pieces, which would, no doubt, be isotopes of known elements, but not neighbors of the elements subjected to radiation."

No one took Ida Noddack's suggestion seriously. The energy required to smash a heavy nucleus into fragments was believed to be so enormous that it seemed ridiculous to suggest that this could be accomplished by a slow neutron.

Many other laboratories began to bombard uranium and thorium with slow neutrons to produce "transuranic elements". In Paris, Irène Joliot-Curie and Paul Savitch worked on this problem, while at the Kaiser Wilhelm Institute in Berlin, Otto Hahn (1879-1968), Lise Meitner (1878-1968) and Fritz Strassmann (1902-) did the same.

Meanwhile, night was falling on Europe. In 1929, an economic depression, caused in part by the shocks of the First World War, began in the United States; and it soon spread to Europe. Without the influx of American capital, the postwar reconstruction of the German economy collapsed. The German middle class, which had been dealt a severe blow by the great inflation of 1923, now received a second heavy blow. The desperation produced by economic chaos drove the German voters into the hands of political extremists.

On January 30, 1933, Adolf Hitler was appointed Chancellor and leader of a coalition cabinet by President Hindenberg. Although Hitler was appointed legally to this post, he quickly consolidated his power by unconstitutional means: On May 2, Hitler's police seized the headquarters of all trade unions, and arrested labor leaders. The Communist and Socialist parties were also banned, their assets seized and their leaders arrested. Other political parties were also smashed. Acts were passed eliminating Jews from public service; and innocent Jewish citizens were boycotted, beaten and arrested.

On March 11, 1938, Nazi troops entered Austria. Lise Meitner, who was working with Otto Hahn in Berlin, was a Jew, but until Hitler's invasion of Austria, she had been protected by her Austrian citizenship. Now, she was forced to escape from Germany. Saying goodbye only to Otto Hahn and to a few other close friends, she went to Holland for a vacation, from which she did not plan to return. From there, she went to Stockholm, where she had been offered a post by the Nobel Institute.

Meanwhile, Hahn and Strassmann continued to work on what they believed to be production of transuranic elements. They had been getting results which differed from those of the Paris group, but they believed that Irène Joliot-Curie must be mistaken. When Strassmann tried to show Hahn one of the new papers from Paris, he continued to puff calmly on his cigar and replied: "I am not interested in our lady-friend's latest writings". However, Strassmann would not be deterred, and he quickly summarized the most recent result from Paris.

"It struck Hahn like a thunderbolt", Strassmann said later, "He never finished that cigar. He laid it down, still glowing, on his desk, and ran downstairs with me to the laboratory."

Hahn and Strassmann quickly repeated the experiments which Irène Joliot-Curie had reported. They now suspected that one of the products which she had produced was actually an isotope of radium. Since radium has almost the same chemical properties as barium, they tried percipitating it together with a barium carrier. This procedure worked: The new substance came down with the barium.

Otto Hahn was the most experienced radiochemist in the world, and many years previously he had developed a method for separating radium from barium. He and Strassmann now tried to apply this method. It did not work. No matter how they tried, they could not separate the active substance from barium.

Could it be that an isotope of barium had been produced by bombarding uranium with neutrons? Impossible! It would mean that the uranium nucleus had split roughly in half, against all the well-established rules of nuclear physics. It could not happen - and yet their chemical tests told them again and again that the product really was barium. Finally, they sat down and wrote a paper:

"We come to this conclusion", Hahn and Strassmann wrote, "Our 'radium' isotopes have the properties of barium. As chemists, we are in fact bound to affirm that the new bodies are not radium but barium; for there is no question of elements other than radium and barium being present... As nuclear chemists, we cannot decide to take this step, in contradiction to all previous experience in nuclear physics."

On December 22, 1938, Otto Hahn mailed the this paper to the journal, *Naturwissenschaften*. "After the manuscript was mailed", he said later, "the whole thing seemed so improbable to me that I wished I could get the document back out of the mail box."

After making this strange discovery, Otto Hahn's first act had been to write to Lise Meitner, who had worked by his side for so many years. She received his letter just as she was starting for her Christmas vacation, which was to be spent at the small Swedish town of Kungälv, near Göteborg.

It was even more clear to Lise Meitner than it had been to Hahn that something of tremendous importance had unexpectedly come to light. As it

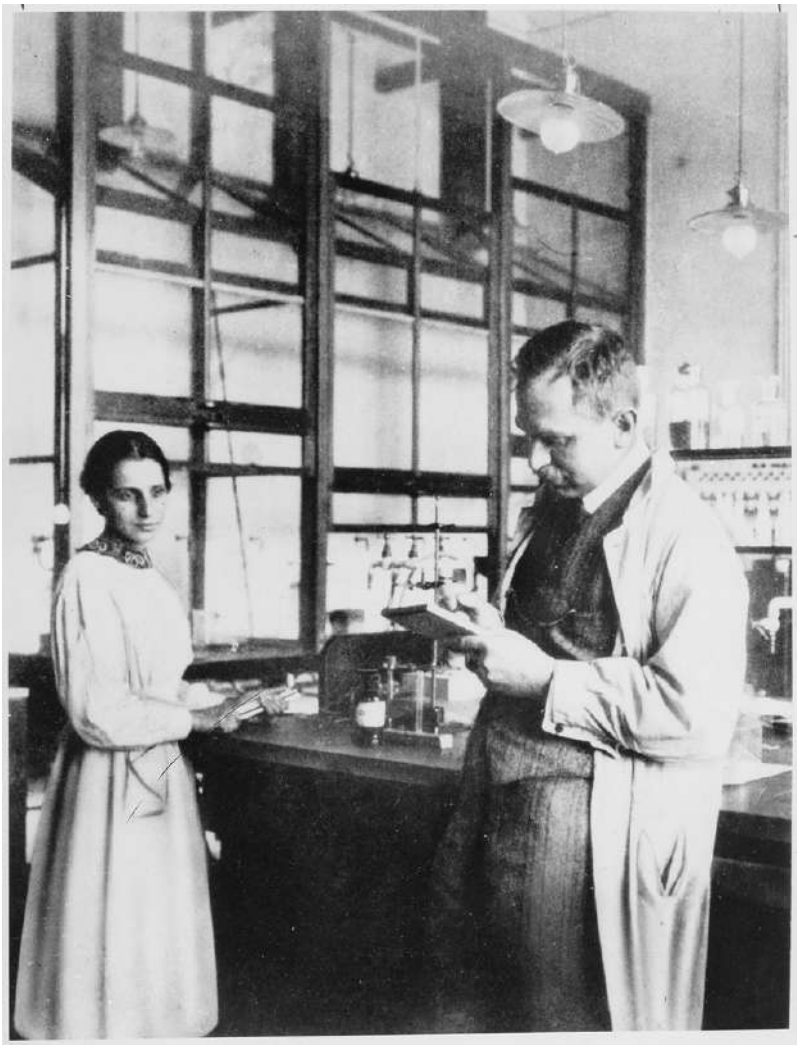

Figure 3.3: *Otto Hahn and Lise Meitner. Public domain, Wikimedia Commons*

happened, Lise Meitner's nephew, O.R. Frisch, had come to Kungälv to spend Christmas with his aunt, hoping to keep her from being lonely during her first Christmas as a refugee. Frisch was a physicist, working at Niels Bohr's institute in Copenhagen. He was one of the many scientists whom Bohr saved from the terror and persecution of Hitler's Germany by offering them refuge in Copenhagen.

When Frisch arrived, Lise Meitner immediately showed him Otto Hahn's letter. "I wanted to discuss with her a new experiment I was planning", Frisch said later, "but she wouldn't listen. I had to read the letter. Its content was indeed so startling that I was at first inclined to be sceptical."

Frisch put on his skis, and went out to get some air; but his aunt followed him over the snow, insisting that he think about the problem of uranium and barium. Lise Meitner knew the precision and thoroughness of Otto Hahn's methods so well that she could not imagine him making a mistake of that kind. If Hahn said that bombarding uranium with neutrons produced barium, then it *did* produce barium. She insisted that her nephew should try to explain this impossible result, rather than shrugging it off as an error.

Finally, aunt and nephew sat down on a log in the middle of the snow-filled Swedish forest and tried to make some calculations on the back of an envelope. They continued their calculations back at their hotel, consulting some tables of isotopic masses which Frisch had brought with him. Gradually, they formed a picture of what had happened:

The uranium nucleus was like a liquid drop. Although the powerfully attractive short-range nuclear forces produced a surface tension which tended to keep the drop together, there were also powerful electrostatic repulsive forces which tended to make it divide. Under certain conditions, the nucleus could become non-spherical in shape, with a narrow waist. If this happened, the electrostatic repulsion would split the nucleus into two fragments, and would drive the fragments apart with tremendous energy of motion.

Frisch and Meitner calculated that for a single uranium nucleus, the energy of motion would be roughly two hundred million electron volts. What was the source of this gigantic energy? By consulting tables of isotopic masses, the two scientists were able to show that in the splitting of uranium, a large amount of the mass is converted to energy. If one of the fragments was an isotope of barium, the other had to be an isotope of krypton. Using Einstein's formula relating energy to mass, they found that the lost mass was exactly equivalent to two hundred million electron volts. Everything checked. This had to be the explanation.

Meitner and Frisch were struck by the colossal size of the energy released in the fission of uranium. Ordinary combustion releases one or two electron volts per atom. They realized with awe that in the fission of uranium, a hundred million times as much energy is released!

When O.R. Frisch returned to Copenhagen, Niels Bohr was preparing to leave for a lecture tour in America. Frisch had only a few minutes to tell him what had happened, but Bohr was quick to understand. "I had hardly begun to tell him", Frisch said later, "when he struck his forehead and exclaimed, 'Oh what idiots we all have been! But this is wonderful! This is just as it must be!'"

There was no time to talk, but as Niels Bohr entered the taxi which would take him to the liner, *Drottningholm*, he asked Frisch whether he had written a paper. Frisch handed some rough notes to Bohr, and said that he would write a paper immediately. Bohr promised that he would not talk about the new discovery until the paper was ready.

Bohr's assistant, Rosenfeld, had accompanied him on the trip, and the long sea voyage to New York gave the two physicists a good opportunity to think about the revolutionary new discovery of nuclear fission. A blackboard was installed in Bohr's stateroom on the *Drottningholm*. Bohr and Rosenfeld covered this blackboard with calculations, and by the end of the voyage, they were convinced that Otto Frisch and Lise Meitner had correctly analysed the problem of nuclear fission.

At the harbor in New York, they were met by Professor John Wheeler of Princeton, together with Enrico Fermi and his wife, Laura, who had become refugees in America. Laura Fermi remembered later the tense and worried expression with which Bohr described the rapidly-deteriorating political situation in Europe. With her imperfect knowledge of English and the noise of the pier, she could only make out a few of the words - "Europe - war - Hitler - danger".

Rosenfeld accompanied Wheeler to Princeton, while Bohr and his 19 year old son, Erik, remained a few days in New York. At Princeton, Rosenfeld was invited to address the "Journal Club", a small, informal group of physicists. Bohr had neglected to tell Rosenfeld that he had promised not to talk about nuclear fission until the Hahn-Strassmann and Meitner-Frisch papers were out; and Rosenfeld spoke about the revolutionary new discovery to the physicists at Princeton.

The news spread with explosive speed. Telephone calls and letters went out to other parts of America. The physicist, I.I. Rabi, who happened to be at Princeton, returned to Colombia University, where Fermi was working, and told him the news. Fermi acted with characteristic speed and decisiveness. He devised an experiment to detect the high-energy fragments produced by uranium fission; and he suggested to his co-worker, Dunning, that the experiment should be performed as fast as possible. Fermi himself had to leave for a theoretical physics meeting in Washington, where Bohr would be present.

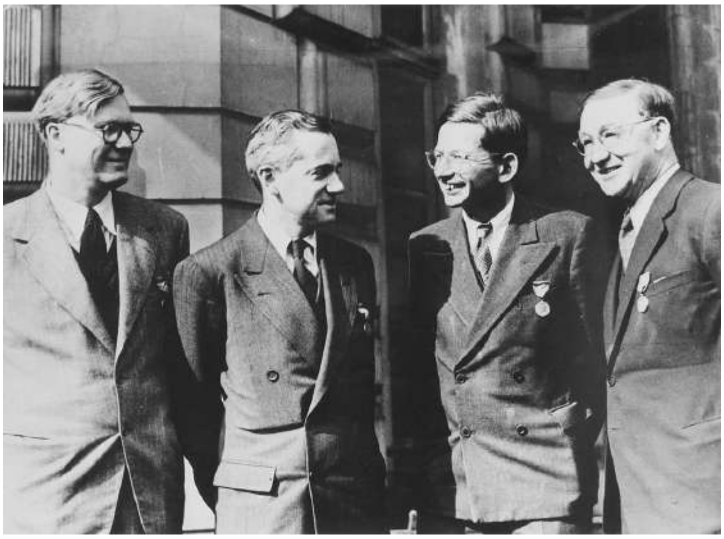

Figure 3.4: *Left to right: William Penney, Otto Frisch, Rudolf Peierls and John Douglas Cockcroft. Public domain, Wikimedia Commons*

When Bohr heard that Rosenfeld had talked about fission, he was very upset, because he had promised Frisch to remain silent until the papers were out. He sent a telegram to Copenhagen urging Frisch to hurry with his manuscript, and urging him to perform an experiment to detect the fission fragments.

In fact, Otto Frisch had already performed this experiment, using a radium-lined ionization chamber containing a radium-beryllium neutron source. An amplifier connected with the chamber had shown giant bursts of ionization, which could only be due to the immensely energetic fission fragments.

On January 16, 1939, the same day that Rosenfeld had revealed the news about fission to the physicists at Princeton, Otto Frisch had mailed two papers to *Nature*. The first of these papers presented the theory of nuclear fission which he and Lise Meitner had developed, while the second described his experimental detection of the high-energy fragments.

On January 26, Bohr and Fermi arrived at the American capital to attend the Fifth Washington Conference on Theoretical Physics. The same day, Erik Bohr received a letter from his brother, Hans. The letter contained the news that Frisch had completed his experiment and had sent the paper to London. Simultaneously, Bohr learned from a reporter who was covering the conference that the Hahn-Strassmann paper had just been published in *Naturwissenschaften*. At last, Bohr felt free to speak. He asked the chairman whether he might make an announcement of the utmost importance; and he told the astonished physicists the whole story.

While Bohr was speaking, Dr. Tuve of the Carnegie Institution whispered to his colleague, Halfstead, that he should quickly put a new filament in the Carnegie accelerator. Several physicists rushed for the door to make long-distance telephone calls. Fermi decided to leave the conference immediately, and to return to New York. On the way out, Fermi met Robert B. Potter, a reporter from *Science Service*, who asked: “What does it all mean?” Fermi explained as well as he could, and Potter wrote the following story, which was released to newspapers and magazines:

“New hope for releasing the enormous energy within the atom has arisen from German experiments that are now creating a sensation among eminent physicists gathered here for the Conference on Theoretical Physics. It is calculated that only five million electron volts of energy can release two hundred million electron volts of energy, forty times the amount shot into it by a neutron (neutral atomic particle). World famous Niels Bohr of Copenhagen and Enrico Fermi of Rome, both Nobel Prize winners, are among those who acclaim this experiment as one of the most important in recent years. American scientists join them in this acclaim.”

Chapter 4

HIROSHIMA AND NAGASAKI

Chain reactions

Within hours of Bohr's announcement, scientists in various parts of America had begun to set up experiments to look for high-energy fission fragments. On the evening of January 26, Bohr watched, while giant pulses of ionization produced by the fission fragments were recorded on an oscilloscope at the Carnegie Institution's accelerator in Washington. Similar experiments were simultaneously being performed in New York and California.

At Columbia University, following Fermi's suggestion, Dunning had performed the experiment a day earlier, on January 25. The news spread rapidly. On the 9th of February, the Austrian physicists, Jentschke and Prankl, reported to the Vienna Academy that they too had observed fission fragments. By March 8, which was Otto Hahn's 60th birthday, an avalanche of papers on uranium fission had developed in the international scientific literature.

In the spring of 1939, Bohr and Wheeler published an important theoretical paper in which they showed that in nuclei with an even atomic mass numbers, the ground state energy is especially low because of pairing of the nuclear particles. For this reason, Bohr and Wheeler believed that it is the rare isotope, urnaium-235, which undergoes fission. They reasoned that when a slow neutron is absorbed by uranium-235, it becomes a highly-excited state of uranium-236. The extra energy of this excited state can deform the nucleus into a non-spherical shape, and the powerful electrostatic repulsive forces between the protons can then cause the nucleus to split.

During the early spring of 1939, a number of scientists, including Fermi, Szilard and the Joliot-Curies, were becoming acutely aware of another question: Are neutrons produced in uranium fission? This was a question of critical importance, because if more than one neutron was produced, a chain reaction might be possible.

At Columbia University, Enrico Fermi and Leo Szilard began experiments to determine whether neutrons are produced; and similar experiments were performed by the Joliot-Curies in Paris. Both groups found that roughly two neutrons are released. This meant that a nuclear chain reaction might indeed be possible: It might be possible to arrange the uranium in such a way that each neutron released by the fission of a nucleus would have a good chance of causing a new fission.

The possibility of nuclear power became clear to the physicists, as well as the possibility of a nuclear bomb many millions of times more powerful than any ordinary bomb. Leo Szilard (who had seen the atrocities of Hitler's Germany at close range) became intensely worried that the Nazis would develop nuclear weapons. Therefore he proposed that the international community of physicists should begin a self-imposed silence concerning uranium fission, and especially concerning the neutrons produced in fission.

In Fermi's words, Szilard "..proceeded to startle physicists by proposing to them that, given the circumstances of the period - you see it was early 1939, and war was very much in the air - given the circumstances of the period, given the danger that atomic energy, and possibly atomic weapons, could become the chief tool of the Nazis to enslave the world, it was the duty of the physicists to depart from what had been the tradition of publishing significant results as soon as the *Physical Review* or other scientific journals might turn them out, and that instead one had to go easy, keep back some of the results until it was clear whether these results were potentially dangerous..."

"He sent in this vein a number of cables to Joliot in France, but he did not get a favorable response from him; and Joliot published his results more or less like results in physics had been published until that day. So the fact that neutrons are emitted in fission in some abundance - the order of magnitude one or two or three - became a matter of general knowledge; and of course that made the possibility of a chain reaction appear to most physicists as a vastly more real possibility than it had until that time."

On March 16, 1939, exactly two months after Bohr had arrived in America, he and Wheeler mailed their paper on uranium fission to a journal. On the same day, Enrico Fermi went to Washington to inform the Office of Naval Operations that it might be possible to construct an atomic bomb; and on the same day, German troops poured into Czechoslovakia.

A few days later, a meeting of six German atomic physicists was held in Berlin to discuss the applications of uranium fission. Otto Hahn, the discoverer of fission, was not present, since it was known that he was opposed to the Nazi regime. He was even said to have exclaimed: "I only hope that you physicists will never construct a uranium bomb! If Hitler ever gets a weapon like that, I'll commit suicide."

The meeting of German atomic physicists was supposed to be secret; but one of the participants reported what had been said to Dr. S. Flügge, who wrote an article about uranium fission and about the possibility of a chain reaction. Flügge's article appeared in the July issue of *Naturwissenschaften*, and a popular version of it was printed in the *Deutsche Allgemeine Zeitung*. These articles greatly increased the alarm of American atomic scientists, who reasoned that if the Nazis permitted so much to be printed, they must be far advanced on the road to building an atomic bomb.

Einstein writes to Roosevelt

In the summer of 1939, while Hitler was preparing to invade Poland, alarming news reached the physicists in the United States: A second meeting of German atomic scientists had been held in Berlin, this time under the auspices of the Research Division of the German Army Weapons Department. Furthermore, Germany had stopped the sale of uranium from mines in Czechoslovakia.

The world's most abundant supply of uranium, however, was not in Czechoslovakia, but in Belgian Congo. Leo Szilard was deeply worried that the Nazis were about to construct atomic bombs; and it occurred to him that uranium from Belgian Congo should not be allowed to fall into their hands.

Szilard knew that his former teacher, Albert Einstein, was a personal friend of Elizabeth, the Belgian Queen Mother. Einstein had met Queen Elizabeth and King Albert of Belgium at the Solvay Conferences, and mutual love of music had cemented a friendship between them. When Hitler came to power in 1933, Einstein had moved to the Institute of Advanced Studies at Princeton; and Szilard decided to visit him there. Szilard reasoned that because of Einstein's great prestige, and because of his long-standing friendship with the Belgian Royal Family, he would be the proper person to warn the Belgians not to let their uranium fall into the hands of the Nazis.

It turned out that Einstein was vacationing at Peconic, Long Island, where he had rented a small house from a friend named Dr. Moore. Leo Szilard set out for Peconic, accompanied by the theoretical physicist, Eugene Wigner, who, like Szilard, was a Hungarian and a refugee from Hitler's Europe.

For some time, the men drove around Peconic, unable to find Dr. Moore's house. Finally Szilard, with his gift for foreseeing the future, exclaimed: "Let's give it up and go home. Perhaps fate never intended it. We should probably be making a frightful mistake in applying to any public authorities in a matter like this. Once a government gets hold of something, it never lets go." However,

Figure 4.1: *Albert Einstein and Leo Szilard with the fateful letter to Roosevelt. Einstein later bitterly regretted signing the letter. Source: priceeconomics.com*

Wigner insisted that it was their duty to contact Einstein and to warn the Belgians, since they might thus prevent a world catastrophe. Finally they found the house by asking a small boy in the street if he knew where Einstein lived.

Einstein agreed to write a letter to the Belgians warning them not to let uranium from the Congo fall into the hands of the Nazis. Wigner suggested that the American State Department ought to be notified that such a letter was being written.

On August 2, 1939, Szilard again visited Einstein, this time accompanied by Edward Teller, who (like Szilard and Wigner) was a refugee Hungarian physicist. By this time, Szilard's plans had grown more ambitious; and he carried with him the draft of a letter to the American President, Franklin D. Roosevelt. Einstein made a few corrections, and then signed the fateful letter, which reads (in part) as follows:

"Some recent work of 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 an important source of energy in the immediate future. Certain aspects of the situation 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.."

"It is conceivable that extremely powerful bombs of a new type may 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..”

“I understand that Germany has actually stopped the sale of uranium from Czechoslovakian mines which she has taken over. That she should have taken such an early action might perhaps be understood on the ground that the son of the German Under-Secretary of State, von Weizäcker, is attached to the Kaiser Wilhelm Institute in Berlin, where some of the American work is being repeated.”

On October 11, 1939, three weeks after the defeat of Poland, Roosevelt’s economic advisor, Alexander Sachs, personally delivered the letter to the President. After discussing it with Sachs, the President commented,“This calls for action.” Later, when atomic bombs were dropped on civilian populations in an already virtually-defeated Japan, Einstein bitterly regretted having signed the letter to Roosevelt.

The first nuclear reactor

As a result of Einstein’s letter, President Roosevelt set up an Advisory Committee on Uranium. On December 6, 1941, the day before the Japanese attack on Pearl Harbor, the Committee decided to make an all-out effort to develop atomic energy and atomic bombs. This decision was based in part on intelligence reports indicating that the Germans had set aside a large section of the Kaiser Wilhelm Institute for Research on uranium; and it was based in part on promising results obtained by Enrico Fermi’s group at Columbia University.

Enrico Fermi and his group at Columbia University had been exploring the possibility of building a chain-reacting pile using natural uranium, together with a moderator to slow the neutrons. Fermi’s own description of the research is as follows:

“...We soon reached the conclusion that in order to have any chance of success with natural uranium, we had to use slow neutrons. So there had to be a moderator. And this moderator could be water, or other substances. Water was soon discarded. It is very effective in slowing down the neutrons, but it absorbs a little bit too many of them, and we couldn’t afford that. Then it was thought that graphite might be a better bet...”

“This brings us to the fall of 1939, when Einstein wrote his now famous letter to Roosevelt, advising him of what was the situation in physics - what was brewing, and that he thought that the government had the duty to take an interest and to help along the development. And in fact, help came along to the tune of six thousand dollars a few months later; and the six thousand dollars were used to buy huge amounts - or what seemed at the time, when the eyes of physicists had not yet been distorted - what seemed at the time a huge amount of graphite."

"So the physicists on the seventh floor of Pupin Laboratories started looking like coal miners, and the wives to whom these physicists came home tired at night were wondering what was happening. We know that there is smoke in the air, but after all..."

"We started to construct this structure that at that time looked again an order of magnitude larger than anything we had seen before. Actually, if anybody would look at this structure now, he would probably extract his magnifying glass and go close to see it. But for the ideas of the time, it looked really big. It was a structure of graphite bricks, and spread through these graphite bricks in some sort of pattern, were big cans, cubic cans, containing uranium oxide."

Fermi's results indicated that it would be possible to make a chain-reacting pile using graphite as a moderator, provided that enough very pure graphite and very pure uranium oxide could be obtained. Leo Szilard undertook the task of procuring the many tons of these substances which would be required.

Work on the pile was moved to the University of Chicago, and the number of physicists employed on the project was greatly enlarged. Work preceeded with feverish speed, because it was feared that the Nazis would win the race. Leona Woods, one of the few women employed on the project, recalled later: "We were told, day and night, that it was our duty to catch up with the Germans."

During the summer of 1942, Fermi succeeded in constructing a uranium-graphite lattice with a neutron reproduction factor greater than unity. In other words, when he put a radium-beryllium neutron source into the lattice, more neutrons came out than were produced by the source. This meant that a chain-reacting pile could definitely be built. It was only a matter of obtaining sufficient amounts of very pure graphite and uranium.

Fermi calculated that a spherical pile, 26 feet in diameter, would be sufficiently large to produce a self-sustained chain reaction. At first, it was planned that the pile should be built at Argonne Laboratory, just outside Chicago. However, the buildings were not yet ready, and therefore Fermi suggested that the pile should instead be built in a squash court under the abandoned football stadium at the University of Chicago. (Football had been banned by the university's president, Robert Hutchens, who felt that it distracted students from their academic work.)

The squash court was not quite as high as Fermi would have liked it to be, and in case of a miscalculation of the critical size of the pile, it would be impossible to add extra layers. Therefore, Fermi and his young co-worker, Herbert Anderson, ordered an enormous cubical rubber balloon from the Goodyear Tyre Company, and the pile was built inside the balloon. The idea was that, if

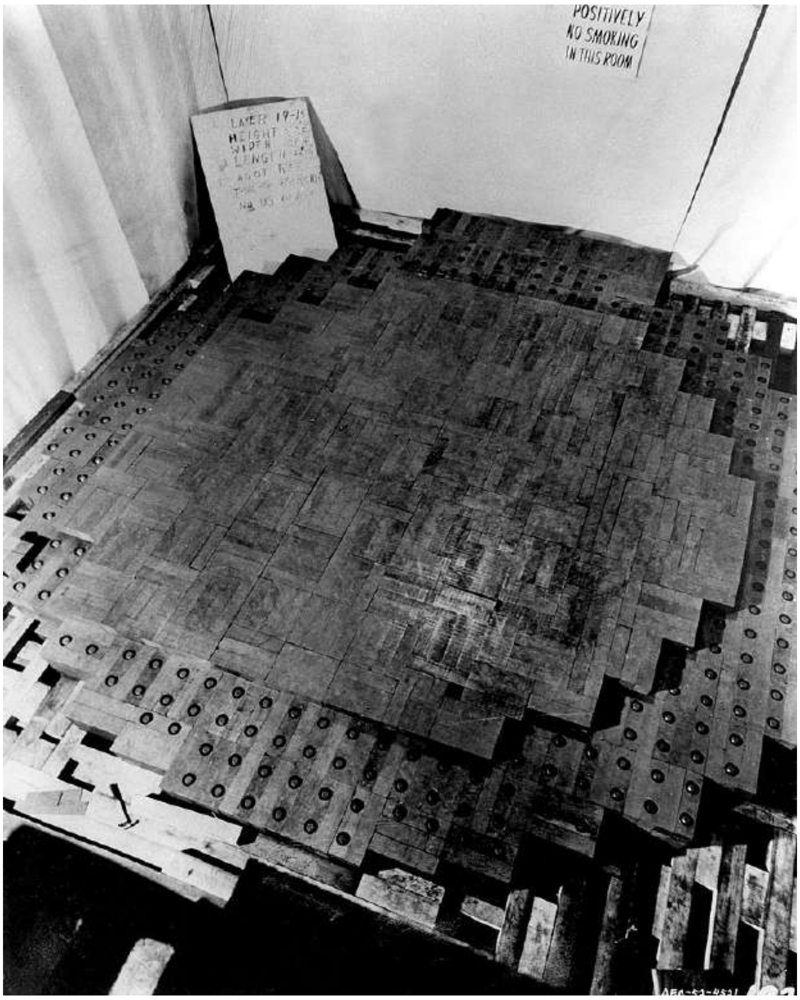

Figure 4.2: *This is the only photograph made during the construction of the first nuclear reactor. Public domain, Wikimedia Commons*

necessary, the air inside the pile could be pumped out to reduce the absorption of neutrons by nitrogen. This turned out not to be necessary; and the door of the balloon was never sealed.

The graphite-uranium lattice was spherical in shape, and it rested on blocks of wood. The physicists labored furiously, putting the tons of uranium and graphite into place, measuring and cutting the blocks of wood needed to support the pile, and swearing to ease the tension. Leona Woods, wearing goggles and overalls, was indistinguishable from the men as she worked on the pile. Everyone was covered from head to foot with black graphite dust, and graphite also made the floor treacherously slippery.

On December 1, 1942, Herbert Anderson stayed up all night putting the finishing touches on the pile. If he had pulled out the neutron absorbing cadmium control rods, Anderson would have been the first man in history to achieve a self-sustaining nuclear chain reaction. However, he had promised Fermi not to do so.

Enrico Fermi got a good night's sleep; and on the next morning, December 2, he was ready to conduct the historic experiment. About forty people were present. Most of them were scientists who had worked on the pile; but there were a few visitors, including a representative of the giant DuPont chemical company, which was undertaking a contract to build more chain-reacting piles.

Fermi, and all the spectators, stood on the balcony of the squash court. On the floor of the court stood a single physicist, George Weil, who was ready to pull out the final control rod. On the top of the pile, crouched in the cramped space under the top of the balloon, was a "suicide squad" - three young physicists who had volunteered to sit there during the experiment with containers of cadmium salt solution, which they would pour into the pile if anything went wrong.

Fermi was confident that nothing would go wrong. He had calculated that even if the last control rod were removed completely, the neutron flux within the pile would not jump rapidly to a high level. Instead, it would begin to increase slowly and steadily. The slow response of the pile was due to the fact that much time was required for the fast neutrons released by fission to be slowed by collisions with carbon atoms in the graphite moderator.

Although, according to theory, there was no danger, Fermi approached the chain reaction with great caution. He explained to the spectators that George Weil would pull out the final control rod by very slow stages; and at each stage, measurements would be made to make sure that the behavior of the pile checked with calculations. The neutron flux was measured by Geiger counters, and recorded by a pen on a roll of paper.

"Pull it out a foot, George", Fermi said; and he explained to the spectators: "Now the pen will move up to this point and then level off." The response was

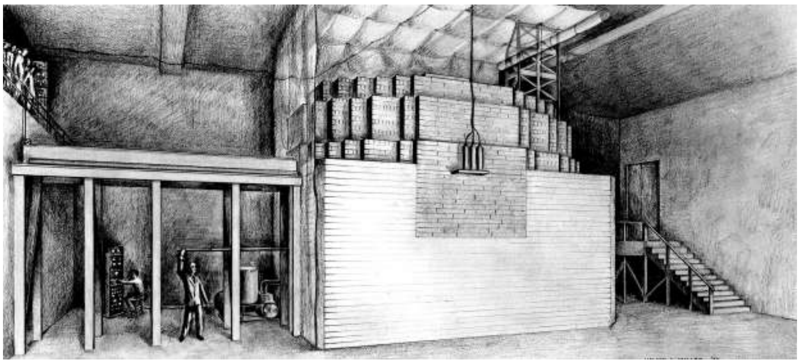

Figure 4.3: *Sketch of the world's first nuclear reactor, Chicago Pile 1 or CP-1, which was constructed under the football grandstands at the University of Chicago. Public domain, Wikimedia Commons*

exactly as predicted.

Throughout the morning, this procedure was repeated. However, by lunchtime, much of the control rod still remained within the pile. Fermi was a man of fixed habits, and although no one else showed any signs of being hungry, he said: "Let's go to lunch."

After lunch, the experiment was continued; and by 2:30 in the afternoon, the critical point was reached. "Pull it out another foot, George", Fermi said, and then he added: "This will do it. Now the pile will chain-react." The Geiger counters began to click faster and faster, and the recording pen moved upward with no sign of leveling off. On top of the pile, the suicide squad waited tensely with their containers of cadmium solution.

Leona Woods whispered to Fermi: "When do we get scared?" However, the pile behaved exactly as predicted, and after 28 minutes, the control rod was reinserted. Eugene Wigner then produced a bottle of Chianti wine which he had kept concealed until that moment, and everyone drank a little, in silence, from paper cups.

The atomic bomb

The chain-reacting pile had a double significance: Its first meaning was a hopeful one - It represented a new source of energy for mankind. The second meaning was more sinister - It was a step on the road to the construction of atomic bombs.

According to the Bohr-Wheeler theory, it was predicted that plutonium-239 should be just as fissionable as uranium-235. Instead of trying to separate the rare isotope, uranium-235, from the common isotope, uranium-238, the physicists could just operate the pile until a sufficient amount of plutonium accumulated, and then separate it out by ordinary chemical means.

This was done on a very large scale by the Dupont chemical company. Four large chain-reacting piles were built beside the Colombia River at Hanford, Washington. Cold water from the river was allowed to flow through the piles to carry away the heat.

An alternative method for producing atomic bombs was to separate the rare fissionable isotope of uranium from the common isotope. Three different methods for isotope separation seemed possible: One could make a gaseous compound of uranium and allow it to diffuse through a porous barrier. (The lighter isotope would diffuse slightly faster.) Alternatively, one could use a high-speed gas centrifuge; or one could separate the isotopes in a mass spectrograph.

All three methods of isotope separation were tried, and all proved successful. Under Harold Urey's direction, a huge plant to carry out the gaseous separation methods was constructed at Oak Ridge Tennessee; and at the University of California in Berkeley, Ernest O. Lawrence and his group converted the new giant cyclotron into a mass spectrograph. Ultimately, 150,000 people were working at Hanford, Oak Ridge and Berkeley, producing material for atomic bombs. Of these, only a few knew the true purpose of the work in which they were engaged.

Calculations performed in England by Otto Frisch and Rudolf Peierels showed that the critical mass of fissionable material needed for a bomb was about two kilograms. If this mass of material were suddenly assembled, a chain-reaction would start spontaneously. An avalanche of neutrons would develop with almost-instantaneous speed, because no time would be needed for the neutrons to be slowed by a moderator. The lower efficiency of the fast neutrons would be offset by the high concentration of fissionable nuclei, and the result would be a nuclear explosion.

Following a joint decision by Roosevelt and Churchill, English work on atomic bombs was moved to the United States and Canada, where it was combined with the research already being conducted there by American and refugee European scientists. Work on the bomb project was driven forward by an overpowering fear that the Nazis would be the first to construct nuclear weapons.

In July, 1943, Robert Oppenheimer of the University of California was appointed director of a secret laboratory where atomic bombs would be built as soon as material for them became available. At the time of his appointment, Oppenheimer was 39 years old. He was a tall, thin man, with refined manners, and a somewhat ascetic appearance.

Oppenheimer was the son of a wealthy and cultured New York financier. He had graduated from Harvard with record grades, and had done postgraduate work in theoretical physics under Max Born at the University of Göttingen in Germany.

Robert Oppenheimer had then worked with E.O. Lawrence, who was separating the isotopes of uranium, using the Berkeley cyclotron, which had been converted to a mass spectrograph. After making a technical innovation which greatly reduced the cost of separation, Oppenheimer had been appointed the head of the theoretical group of the atomic bomb project. He proved to be a gifted leader. His charm was hypnotic; and under his leadership, "something got done, and done at astonishing speed", as Arthur Compton said later.

Oppenheimer proposed that all work on building atomic bombs should be assembled in a secret laboratory. This proposal was adopted; and because Oppenheimer had shown such gifts as a leader, he was made head of the secret laboratory.

At first, it was planned that this laboratory should be located near to the huge isotope separation plant at Oak Ridge, Tennessee. However, spies often were set on shore on the Atlantic coast of the United States by German submarines; and a number of spies were captured near to Oak Ridge. Therefore, Oppenheimer and General Leslie Groves (the military director of the project) looked for a more isolated site in the western part of the country.

Oppenheimer had boyhood memories of New Mexico, where he and his brother, Frank, had spent their vacations. He took General Groves to a boy's school, which he remembered, on a high plateau near the Los Alamos canyon. The mesa where the boy's school was located was the flat top of a mountain, 7,000 feet above sea level, overlooking the valley of the Rio Grande River.

It was a completely isolated place. Apart from the few buildings of the school, one saw only scattered aspens and fragrant pines, the red rock of the mesa, and the Jemez mountains on the horizon, standing out sharply in the dry, transparent air. Sixty miles separated Los Alamos from the nearest railway station, at Santa Fe, New Mexico.

Oppenheimer and Groves decided that this would be an excellent place for the secret laboratory which they were planning; and they told the headmaster that the school would have to be closed. It would be bought for government war work. The buildings of the school would accommodate the first scientists arriving at Los Alamos while other buildings were being constructed.

Within a year of the first visit to the lonely mesa by Oppenheimer and Groves, 3,500 people were working there; and in another year, the population of scientists and their families had grown to 6,000. More and more scientists received visits from the persuasive young director, Robert Oppenheimer; and more and more of them disappeared to the mysterious "Site Y", a place so secret that its location and name could not be mentioned, and knowledge of

Figure 4.4: *Oppenheimer with General Leslie Groves, military head of the Manhattan Project. Public domain, Wikimedia Commons*

its mere existence was limited to very few people.

Many of the scientists who had fled from Hitler's Europe found themselves reunited with their friends at "Site Y". Fermi, Segrè, Rossi, Bethe, Peierls, Chadwick, Frisch, Szilard and Teller all were there. Even Niels Bohr arrived at Los Alamos, together with his son, Aage, who was also a physicist.

Bohr had remained in Denmark as long as possible, in order to protect his laboratory and his co-workers. However, in 1943, he heard that he had been marked by the Germans for arrest and deportation; and he escaped to Sweden in a small boat. In Sweden, he helped to rescue the Jewish population of Denmark from the Nazis; and finally he arrived at Los Alamos.

As time passed, many of the scientists at Los Alamos, including Niels Bohr, became deeply worried about the ethical aspects of work on the atomic bomb. When the project had first begun, everyone was sure that the Germans had a great lead in the development of nuclear weapons. They were convinced that the only way to save civilization from the threat of Nazi atomic bombs would be to have a counter-threat. In 1944, however, as the Allied invasion of Europe began, and no German atomic bombs appeared, this dogma seemed less certain.

In 1943, a special intelligence unit of the American Army had been established. Its purpose was to land with the first Allied troops invading Europe, and to obtain information about the German atomic bomb project. The code-name of the unit was *Aslos*, a literal Greek translation of the name of General Groves. The Dutch refugee physicist, Samuel Goudschmidt, was the scientific director of the *Aslos* mission.

When Strasbourg fell to the Allies, Goudschmidt found documents which made it clear that the Germans had not even come close to building atomic bombs. While walking with one of his military colleagues, Goudschmidt exclaimed with relief, "Isn't it wonderful? The Germans don't have atomic bombs! Now we won't have to use ours!"

He was shocked by the reply of his military colleague: "Of course you understand, Sam, that if we have such a weapon, we are going to use it." Goudschmidt's colleague unfortunately proved to have an accurate understanding of the psychology of military and political leaders.

The news that the Germans would not produce atomic bombs was classified as a secret. Nevertheless, it passed through the grapevine to the scientists working on the atomic bomb project in America; and it reversed their attitude to the project. Until then, they had been worried that Hitler would be the first to produce nuclear weapons. In 1944, they began to worry instead about what the American government might do if it came to possess such weapons.

At Los Alamos, Niels Bohr became the center of discussion and worry about the ethics of continued work on the bomb project. He was then 59 years old; and he was universally respected both for his pioneering work in atomic physics, and for his outstandingly good character.

Bohr was extremely worried because he foresaw a postwar nuclear arms race unless international control of atomic energy could be established. Consequently, as a spokesman for the younger atomic scientists, he approached both Roosevelt and Churchill to urge them to consider means by which international control might be established.

Roosevelt, too, was worried about the prospect of a postwar nuclear armaments race; and he was very sympathetic towards Bohr's proposals for international control. He suggested that Bohr travel to England and contact Churchill, to obtain his point of view.

Churchill was desperately busy, and basically unsympathetic towards Bohr's proposals; but on May 16, 1944, he agreed to a half-hour interview with the scientist. The meeting was a complete failure. Churchill and his scientific advisor, Lord Cherwell, spent most of the time talking with each other, so that Bohr had almost no time to present his ideas.

Although he could be very persuasive in long conversations, Bohr was unable to present his thoughts briefly. He wrote and spoke in a discursive style, similar to that of Henry James. Each of his long, convoluted sentences was heavily weighted with qualifications and dependent clauses. At one point in the conversation, Churchill turned to Lord Cherwell and asked: "What's he talking about, physics or politics?"

Bohr's low, almost whispering, way of speaking irritated Churchill. Furthermore, the two men were completely opposed in their views: Bohr was urging openness in approaching the Russians, with a view to establishing international control of nuclear weapons. Churchill, a defender of the old imperial order, was concerned mainly with maintaining British and American military supremacy.

After the interview, Churchill became worried that Bohr would give away "atomic secrets" to the Russians; and he even suggested that Bohr be arrested. However, Lord Cherwell explained to the Prime Minister that the possibility of making atomic bombs, as well as the basic means of doing so, had been common knowledge in the international scientific community ever since 1939.

After his disastrous interview with Churchill, Niels Bohr carefully prepared a memorandum to be presented to President Roosevelt. Realizing how much depended on its success or failure, Bohr wrote and rewrote the memorandum, sweating in the heat of Washington's summer weather. Aage Bohr, who acted as his father's secretary, typed the memorandum over and over, following his father's many changes of mind.

Finally, in July, 1944, Bohr's memorandum was presented to Roosevelt. It contains the following passages:

"...Quite apart from the question of how soon the weapon will be ready for use, and what role it will play in the present war, this situation raises a number of problems which call for urgent attention. Unless, indeed, some agreement about the control of the new and active materials can be obtained in due time, any temporary advantage, however great, may be outweighed by a perpetual menace to human society."

"Ever since the possibilities of releasing atomic energy on a vast scale came into sight, much thought has naturally been given to the question of control; but the further the exploration of the scientific problems is proceeding, the clearer it becomes that no kind of customary measures will suffice for this purpose, and that the terrifying prospect of a future competition between nations about a weapon of such formidable character can only be avoided by a universal agreement in true confidence..."

Roosevelt was sympathetic with the ideas expressed in this memorandum. In an interview with Bohr, he expressed his broad agreement with the idea of international control of atomic energy. Unfortunately, the President had only a few months left to live.

At the University of Chicago, worry and discussion were even more acute than at Los Alamos. The scientists at Chicago had better access to the news, and more time to think. A committee of seven was elected by the Chicago scientists to draft their views into a report on the social and political consequences of atomic energy. The chairman of the committee was the Nobel-laureate physicist James Franck, a man greatly respected for his integrity.

The Franck Report was submitted to the American Secretary of War in June, 1945; and it contains the following passages:

"In the past, science has been able to provide new methods of protection against new methods of aggression it made possible; but it cannot promise such effective protection against the destructive use of nuclear energy. This protection can only come from the political organization of the world. Among all the arguments calling for an efficient international organization for peace, the existence of nuclear weapons is the most compelling one..."

"If no efficient international agreement is achieved, the race for nuclear armaments will be on in earnest not later than the morning after our first demonstration of the existence of nuclear weapons. After this, it might take other nations three or four years to overcome our present head start..."

"It is not at all certain that American public opinion, if it could be enlightened as to the effect of atomic explosives, would approve of our own country being the first to introduce such an indiscriminate method for the wholesale destruction of civilian life... The military advantages, and the saving of American lives, achieved by a sudden use of atomic bombs against Japan, may be outweighed by a wave of horror and revulsion sweeping over the rest of the world, and perhaps even dividing public opinion at home...”

“From this point of view, a demonstration of the new weapon might best be made, before the eyes of representatives of all the United Nations, on the desert, or on a barren island. The best possible atmosphere for.. an international agreement could be achieved if America could say to the world: ‘You see what sort of weapon we had but did not use. We are ready to renounce its use in the future, if other nations join us in this renunciation, and join us in the establishment of an efficient control’.”

“One thing is clear: Any international agreement on the prevention of nuclear armaments must be backed by actual and effective controls. No paper agreement can be sufficient, since neither this nor any other nation can stake its whole existence on trust in other nations’ signatures.”

The Franck report then goes on to outline the steps which would have to be taken in order to establish efficient international control of atomic energy. The report states that the most effective method would be for an international control board to restrict the mining of uranium ore. This would also prevent the use of atomic energy for generating electrical power; but the price would not be too high to pay in order to save humankind from the grave dangers of nuclear war.

Unfortunately, it was too late for the scientists to stop the machine which they themselves had set in motion. President Franklin Roosevelt might have stopped the use of the bomb; but in August, 1945, he was dead. On his desk, unread, lay letters from Albert Einstein and Leo Szilard - the same men who had written to Roosevelt six years previously, thus initiating the American atomic bomb project. In 1945, both Einstein and Szilard wrote again to Roosevelt, this time desperately urging him not to use nuclear weapons against Japan; but their letters arrived too late.

In Roosevelt’s place was a new President, Harry Truman, who had been in office only a few weeks. He came from a small town in Missouri; and he was shocked to find himself suddenly thrust into a position of enormous power. He was overwhelmed with new responsibilities, and was cautiously feeling his way. Until Roosevelt’s death he had known nothing whatever about the atomic bomb project; and he therefore had little chance to absorb its full meaning.

By contrast, General Leslie Groves, the military commander of the bomb project, was very sure of himself; and he was determined to use atomic bombs against Japan. General Groves had supervised the spending of two billion dollars of the American taxpayers’ money. He was anxious to gain credit for winning the war, rather than to be blamed for the money’s misuse.

Under these circumstances, it is understandable that Truman did nothing to stop the use of the atomic bomb. In General Groves’ words, “Truman did not so much say ‘yes’, as not say ‘no’. It would, indeed, have taken a lot of nerve to say 'no' at that time."

August 6

On August 6, 1945, at 8:15 in the morning, an atomic bomb was exploded in the air over Hiroshima. The force of the explosion was equivalent to twenty thousand tons of T.N.T.. Out of a city of two hundred and fifty thousand people, almost one hundred thousand were killed by the bomb; and another hundred thousand were hurt.

In some places, near the center of the city, people were completely vaporized, so that only their shadows on the pavement marked the places where they had been. Many people who were not killed by the blast or by burns from the explosion, were trapped under the wreckage of their houses. Unable to move, they were burned to death in the fire which followed.

Some accounts of the destruction of Hiroshima, written by children who survived it, have been collected by Professor Arata Osada. Among them is the following account, written by a boy named Hisato Ito. He was 11 years old when the atomic bomb was exploded over the city:

"On the morning of August 5th (we went) to Hiroshima to see my brother, who was at college there. My brother spent the night with us in a hotel... On the morning of the 6th, my mother was standing near the entrance, talking with the hotel proprietor before paying the bill, while I played with the cat. It was then that a violent flash of blue-white light swept in through the doorway."

"I regained consciousness after a little while, but everything was dark. I had been flung to the far end of the hall, and was lying under a pile of debris caused by the collapse of two floors of the hotel. Although I tried to crawl out of this, I could not move. The fine central pillar, of which the proprietor was so proud, lay flat in front of me. "

"I closed my eyes and was quite overcome, thinking that I was going to die, when I heard my mother calling my name. At the sound of her voice, I opened my eyes; and then I saw the flames creeping close to me. I called frantically to my mother, for I knew that I should be burnt alive if I did not escape at once. My mother pulled away some burning boards and saved me. I shall never forget how happy I felt at that moment - like a bird let out of a cage."

"Everything was so altered that I felt bewildered. As far as my eyes could see, almost all the houses were destroyed and on fire. People passed by, their bodies red, as if they had been peeled. Their cries were pitiful. Others were dead. It was impossible to go farther along the street on account of the bodies, the ruined houses, and the badly wounded who lay about moaning. I did not

Figure 4.5: *It was like a scene from hell. Source: SGI International.*

know what to do; and as I turned to the west, I saw that the flames were drawing nearer..”

“At the water’s edge, opposite the old Sentai gardens, I suddenly realized that I had become separated from my mother. The people who had been burned were plunging into the river Kobashi, and then were crying our: ‘It’s hot! It’s hot!’ They were too weak to swim, and they drowned while crying for help.”

In 1951, shortly after writing this account, Hisato Ito died of radiation sickness. His mother died soon afterward from the same cause.

When the news of the atomic bombing of Hiroshima and Nagasaki reached Albert Einstein, his sorrow and remorse were extreme. During the remainder of his life, he did his utmost to promote the cause of peace and to warn humanity against the dangers of nuclear warfare.

When Otto Hahn, the discoverer of fission, heard the news of the destruction of Hiroshima, he and nine other German atomic scientists were being held prisoner at an English country house near Cambridge. Hahn became so depressed that his colleagues feared that he would take his own life.

Among the scientists who had worked at Chicago and Los Alamos, there was relief that the war was over; but as descriptions of Hiroshima and Nagasaki became available, there were also sharp feelings of guilt. Many scientists who had worked on the bomb project made great efforts to persuade the governments of the United States, England and Russia to agree to international control of atomic energy; but these efforts met with failure; and the nuclear arms race feared by Bohr developed with increasing momentum.

Figure 4.6: *Burned beyond recognition. Source: SGI International.*

Figure 4.7: *Memories of August 6. Source: SGI International.*

Figure 4.8: *The effects lasted a lifetime. Source: SGI International.*

Figure 4.9: *After the bombing. Source: SGI International.*

Suggestions for further reading

1. Robert Jungk, *Brighter Than a Thousand Suns*, Pennguin Books Ltd. (1964).
2. Werner Braunbeck, *The Drama of the Atom*, Oliver and Boyd, Edinburgh (1958).
3. Werner Heisenberg, *Physics and Beyond; Memories of a Life in Science*, George Allen and Unwin (1971).
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5. Laura Fermi, *Atoms in the Family*, The University of Chicago Press (1954).
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7. James L. Henderson, *Hiroshima*, Longmans (1974).
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10. Marion Yass, *Hiroshima*, G.P. Putnam's Sons, New York (1972).
11. Robert Jungk, *Children of the Ashes*, Harcourt, Brace and World (1961).
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13. John Hersey, *Hiroshima*, Penguin Books Ltd. (1975).

Chapter 5

THE THREAT OF NUCLEAR WAR

“The unleashed power of the atom has changed everything except our ways of thinking, and thus we drift towards unparalleled catastrophes.”

“I don’t know what will be used in the next world war, but the 4th will be fought with stones.”

Albert Einstein

Figure 5.1: *Saint Paul's Cathedral during the London Blitz. Determined firefighting by citizens saved the cathedral from burning,* (Wikipedia)

Introduction

Today, the greatest threats facing human civilization and the biosphere are catastrophic climate change and nuclear war. Each of these could potentially destroy our civilization, kill most humans, and make most of our planet uninhabitable for most species, including our own.

The peoples of the world must unite and work with dedication to avoid these twin threats.

Figure 5.2: *A view of Dresden after the firebombing with a statue of "Goodness" in the foreground.* (Wikipedia)

Targeting civilians

The erosion of ethical principles during World War II

When Hitler invaded Poland in September, 1939, US President Franklin Delano Roosevelt appealed to Great Britain, France, and Germany to spare innocent civilians from terror bombing. "The ruthless bombing from the air of civilians in unfortified centers of population during the course of the hostilities", Roosevelt said (referring to the use of air bombardment during World War I) "...has sickened the hearts of every civilized man and woman, and has profoundly shocked the conscience of humanity." He urged "every Government which may be engaged in hostilities publicly to affirm its determination that its armed forces shall in no event, and under no circumstances, undertake the bombardment from the air of civilian populations or of unfortified cities."

Two weeks later, British Prime Minister Neville Chamberlain responded to Roosevelts appeal with the words: "Whatever the lengths to which others may go, His Majesty's Government will never resort to the deliberate attack on women and children and other civilians for purposes of mere terrorism."

Much was destroyed during World War II, and among the casualties of the war were the ethical principles that Roosevelt and Chamberlain announced at its outset. At the time of Roosevelt and Chamberlains declarations, terror bombing of civilians had already begun in the Far East. On 22 and 23 September, 1937, Japanese bombers attacked civilian populations in Nanjing and Canton. The attacks provoked widespread protests. The British Under Secretary of State for Foreign Affairs, Lord Cranborne, wrote: "Words cannot express the feelings of profound horror with which the news of these raids has been received by the whole civilized world. They are often directed against places far from the actual area of hostilities. The military objective, where it exists, seems to take a completely second place. The main object seems to be to inspire terror by the indiscriminate slaughter of civilians..."

On the 25th of September, 1939, Hitlers air force began a series of intense attacks on Warsaw. Civilian areas of the city, hospitals marked with the Red Cross symbol, and fleeing refugees all were targeted in a effort to force the surrender of the city through terror. On the 14th of May, 1940, Rotterdam was also devastated. Between the 7th of September 1940 and the 10th of May 1941, the German Luftwaffe carried out massive air attacks on targets in Britain. By May, 1941, 43,000 British civilians were killed and more than a million houses destroyed.

By the end of the war the United States and Great Britain were bombing of civilians on a far greater scale than Japan and Germany had ever done. For example, on July 24-28, 1943, British and American bombers attacked

Hamburg with an enormous incendiary raid whose official intention was "the total destruction" of the city.

The result was a firestorm that did, if fact, lead to the total destruction of the city. One airman recalled, that "As far as I could see was one mass of fire. A sea of flame has been the description, and thats an understatement. It was so bright that I could read the target maps and adjust the bomb-sight." Another pilot was "...amazed at the awe-inspiring sight of the target area. It seemed as though the whole of Hamburg was on fire from one end to the other and a huge column of smoke was towering well above us - and we were on 20,000 feet! It all seemed almost incredible and, when I realized that I was looking at a city with a population of two millions, or about that, it became almost frightening to think of what must be going on down there in Hamburg."

Below, in the burning city, temperatures reached 1400 degrees Fahrenheit, a temperature at which lead and aluminum have long since liquefied. Powerful winds sucked new air into the firestorm. There were reports of babies being torn by the high winds from their mothers arms and sucked into the flames. Of the 45,000 people killed, it has been estimated that 50 percent were women and children and many of the men killed were elderly, above military age. For weeks after the raids, survivors were plagued by "...droves of vicious rats, grown strong by feeding on the corpses that were left unburied within the rubble as well as the potatoes and other food supplies lost beneath the broken buildings."

The German cities Kassel, Pforzheim, Mainz, Dresden and Berlin were similarly destroyed, and in Japan, US bombing created firestorms in many cities, for example Tokyo, Kobe and Yokohama. In Tokyo alone, incendiary bombing caused more than 100,000 civilian casualties.

Hiroshima and Nagasaki

On August 6, 1945, at 8:15 in the morning, an atomic bomb was exploded in the air over Hiroshima. The force of the explosion was equivalent to twenty thousand tons of T.N.T.. Out of a city of two hundred and fifty thousand people, almost one hundred thousand were killed by the bomb; and another hundred thousand were hurt.

In some places, near the center of the city, people were completely vaporized, so that only their shadows on the pavement marked the places where they had been. Many people who were not killed by the blast or by burns from the explosion, were trapped under the wreckage of their houses. Unable to move, they were burned to death in the fire which followed.

Some accounts of the destruction of Hiroshima, written by children who

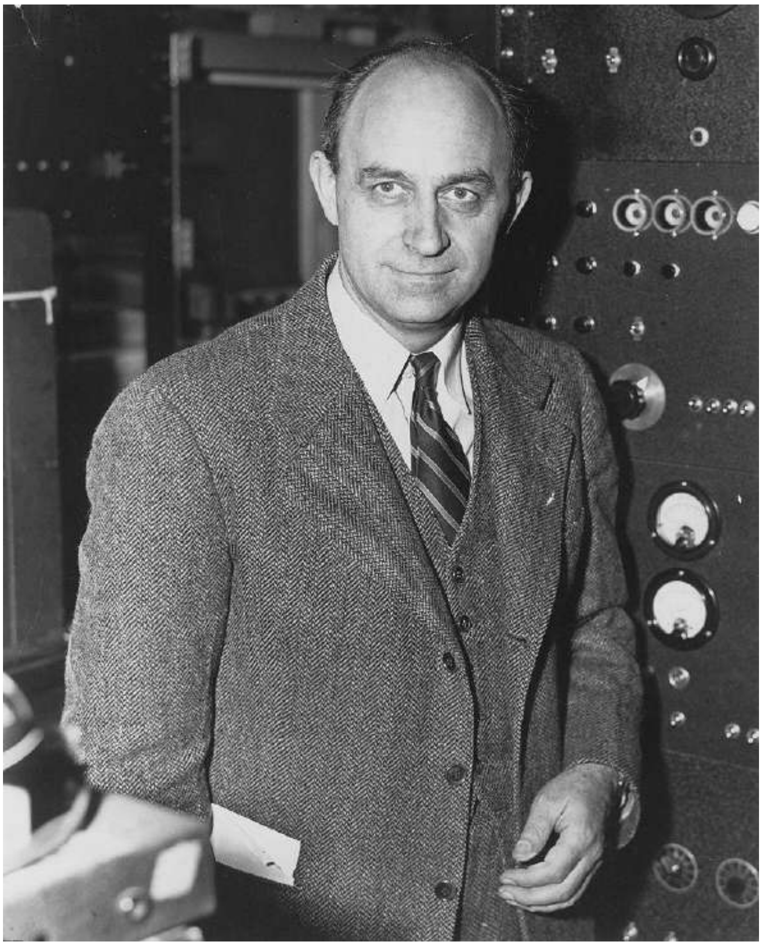

Figure 5.3: *Enrico Fermi (1901–1954). In 1934, he and his team of young Italian physicists split uranium atoms without realizing it.* (Public domain)

survived it, have been collected by Professor Arata Osada. Among them is the following account, written by a boy named Hisato Ito. He was 11 years old when the atomic bomb was exploded over the city:

"On the morning of August 5th (we went) to Hiroshima to see my brother, who was at college there. My brother spent the night with us in a hotel... On the morning of the 6th, my mother was standing near the entrance, talking with the hotel proprietor before paying the bill, while I played with the cat. It was then that a violent flash of blue-white light swept in through the doorway."

"I regained consciousness after a little while, but everything was dark. I had been flung to the far end of the hall, and was lying under a pile of debris caused by the collapse of two floors of the hotel. Although I tried to crawl out of this, I could not move. The fine central pillar, of which the proprietor was so proud, lay flat in front of me. "

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"At the waters edge, opposite the old Sentai gardens, I suddenly realized that I had become separated from my mother. The people who had been burned were plunging into the river Kobashi, and then were crying out: 'Its hot! Its hot! They were too weak to swim, and they drowned while crying for help."

In 1951, shortly after writing this account, Hisato Ito died of radiation sickness. His mother died soon afterward from the same cause.

The postwar nuclear arms race

When the news of the atomic bombing of Hiroshima and Nagasaki reached Albert Einstein, his sorrow and remorse were extreme. During the remainder of his life, he did his utmost to promote the cause of peace and to warn humanity against the dangers of nuclear warfare. Together with Bertrand Russell

Figure 5.4: *Hiroshima* (duniverso.com.br)

Figure 5.5: *Hiroshima. The greater absorption of thermal energy by dark colors resulted in the clothes pattern, in the tight-fitting areas on this survivor, being burnt into the skin.*(Public domain)

Figure 5.6: *Nagasaki before the nuclear explosion and firestorm.* (Public domain)

and Joseph Rotblat he helped to found Pugwash Conferences on Science and World Affairs (Nobel Peace Prize 1995), an organization of scientists and other scholars devoted to world peace and to the abolition of nuclear weapons.

When Otto Hahn, the discoverer of fission, heard the news of the destruction of Hiroshima, he and nine other German atomic scientists were being held prisoner at an English country house near Cambridge. Hahn became so depressed that his colleagues feared that he would take his own life.

World public opinion was also greatly affected by the indiscriminate destruction of human life in Hiroshima and Nagasaki. Shortly after the bombings, the French existentialist author Albert Camus wrote: "Our technical civilization has just reached its greatest level of savagery. We will have to choose, in the more or less near future, between collective suicide and the intelligent use of our scientific conquests. Before the terrifying prospects now available to

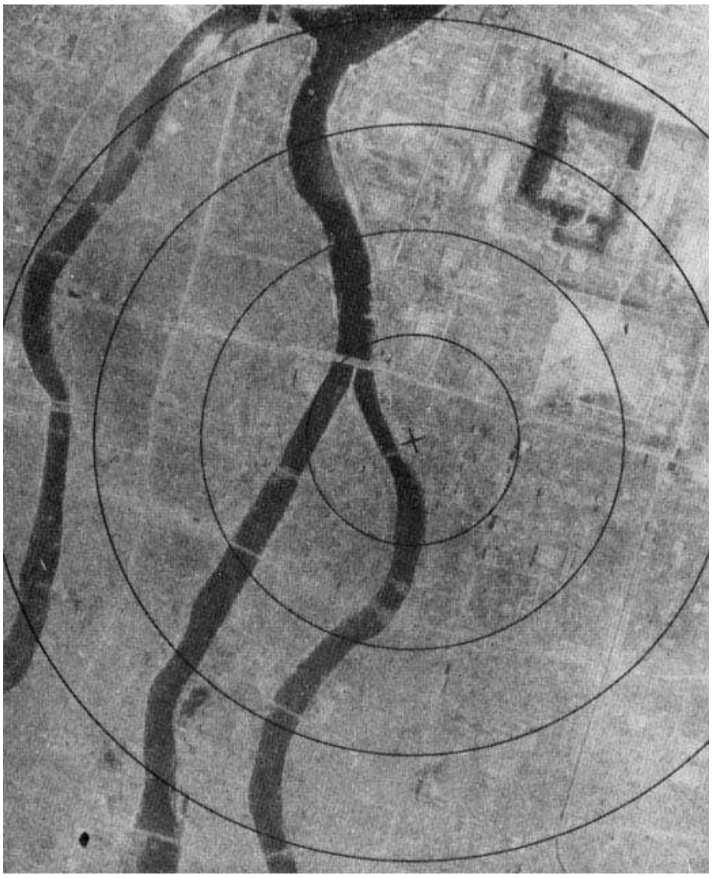

Figure 5.7: *Nagasaki afterwards.* (Public domain)

humanity, we see even more clearly that peace is the only battle worth waging. This is no longer a prayer, but a demand to be made by all peoples to their governments - a demand to choose definitively between hell and reason."

Among the scientists who had worked at Chicago and Los Alamos, there was relief that the war was over; but as descriptions of Hiroshima and Nagasaki became available there were also sharp feelings of guilt. Many scientists who had worked on the bomb project made great efforts to persuade the governments of the United States, England and the Soviet Union to agree to international control of atomic energy; but these efforts met with failure; and the nuclear arms race developed with increasing momentum.

In 1946, the United States proposed the Baruch Plan to internationalize atomic energy, but the plan was rejected by the Soviet Union, which had been conducting its own secret nuclear weapons program since 1943. On August 29, 1949, the USSR exploded its first nuclear bomb. It had a yield equivalent to 21,000 tons of TNT, and had been constructed from Pu-239 produced in a

Figure 5.8: *The United States exploded a hydrogen bomb near the island of Enewetak in the South Pacific in 1952. The explosive force of the bomb was 500 times greater than the bombs that destroyed Hiroshima and Nagasaki. The Soviet Union tested its first hydrogen bomb in 1953. In March, 1954, the US tested another hydrogen bomb at the Bikini Atoll in the Pacific Ocean. It was 1000 times more powerful than the Hiroshima bomb. The Japanese fishing boat, Lucky Dragon, was 130 kilometers from the Bikini explosion, but radioactive fallout from the test killed one crew member and made all the others seriously ill.* (Public domain)

Figure 5.9: *After discussing the Bikini test and its radioactive fallout with Joseph Rotblat, Lord Russell became concerned for the future of the human gene pool if large numbers of such bombs should ever be used in a war. To warn humanity of the danger, he wrote what came to be known as the Russell-Einstein Manifesto. On July 9, 1955, with Rotblat in the chair, Russell read the Manifesto to a packed press conference. The document contains the words: "Here then is the problem that we present to you, stark and dreadful and inescapable: Shall we put an end to the human race, or shall mankind renounce war?... There lies before us, if we choose, continual progress in happiness, knowledge and wisdom. Shall we, instead, choose death because we cannot forget our quarrels? We appeal as human beings to human beings: Remember your humanity, and forget the rest." Lord Russell devoted much of the remainder of his life to working for the abolition of nuclear weapons. Here he is seen in 1962 in Trafalgar Square, London, addressing a meeting of the Campaign for Nuclear Disarmament.* (Public domain)

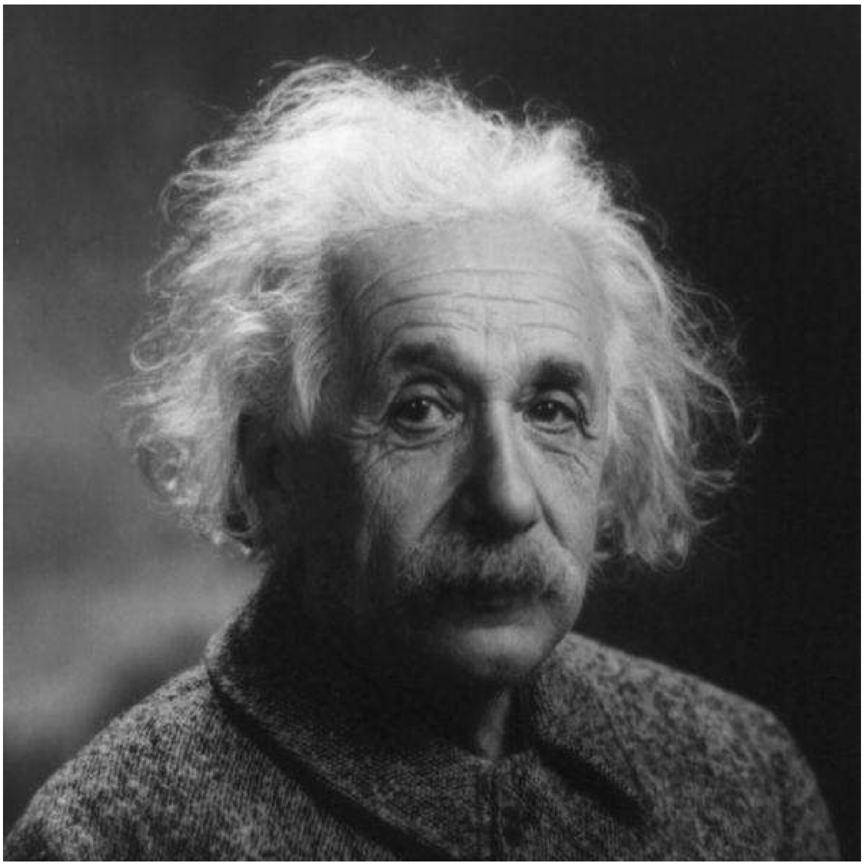

Figure 5.10: *Albert Einstein wrote: "The unleashed power of the atom has changed everything save our modes of thinking, and we thus drift toward unparalleled catastrophes." He also said, "I don't know what will be used in the next world war, but the 4th will be fought with stones."*(Wikimedia)

Figure 5.11: *Joseph Rotblat devoted the remainder of his life to working for peace and for the abolition of nuclear weapons. He became the president and guiding spirit of the Pugwash Conferences on Science and World Affairs, an organization of scientists and other scholars devoted to these goals. In his 1995 Nobel Peace Prize acceptance speech, Sir Joseph Rotblat (as he soon became) emphasized the same point that had been made in the Russell-Einstein Manifesto - that war itself must be eliminated in order to free civilization from the danger of nuclear destruction.* (Pugwash Conferences)

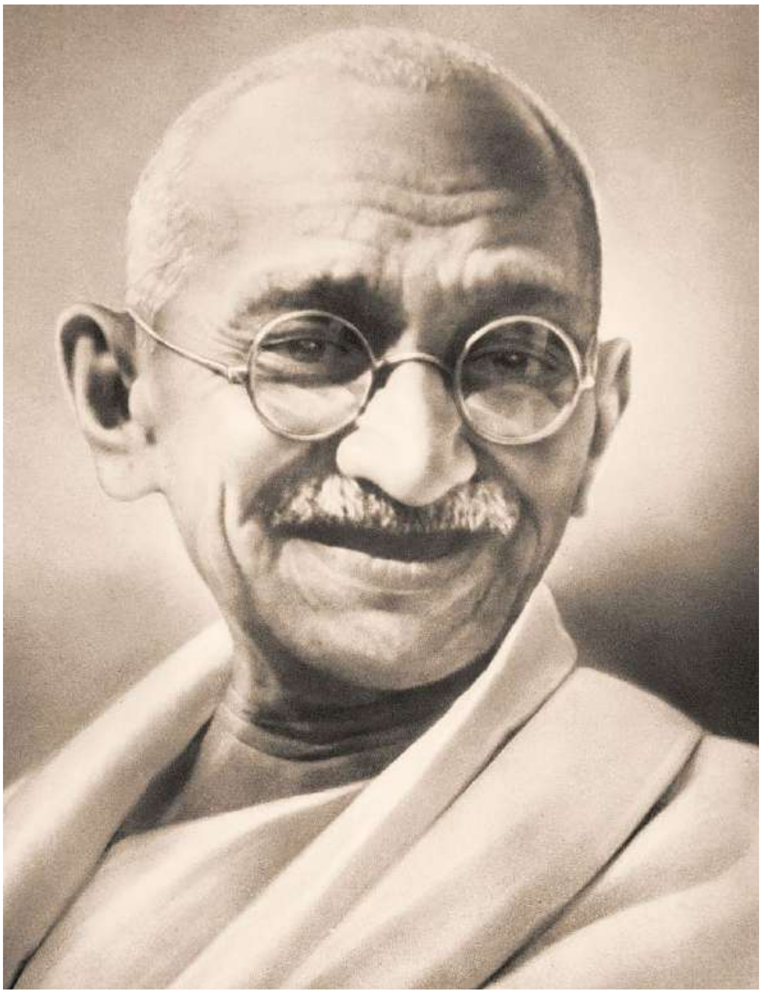

Figure 5.12: *To the insidious argument that "the end justifies the means", Mahatma Gandhi answered firmly: "They say 'means are after all means. I would say 'means are after all everything. As the means, so the end. Indeed the Creator has given us control (and that very limited) over means, none over end... The means may be likened to a seed, and the end to a tree; and there is the same inviolable connection between the means and the end as there is between the seed and the tree. Means and end are convertible terms in my philosophy of life." In other words, if evil means are used, the end achieved will be contaminated by the means used to achieve it. Gandhi's insight can be applied to the argument that the nuclear bombings that destroyed Hiroshima and Nagasaki helped to end World War II and were therefore justified. In fact, these terrible events lead to a nuclear arms race that still casts an extremely dark shadow over the future of human civilization.* (Public domain)

nuclear reactor. Meanwhile the United Kingdom had begun to build its own nuclear weapons.

The explosion of the Soviet nuclear bomb caused feelings of panic in the United States, and President Truman authorized an all-out effort to build superbombs using thermonuclear reactions - the reactions that heat the sun and stars. The idea of using a U-235 fission bomb to trigger a thermonuclear reaction in a mixture of light elements had first been proposed by Enrico Fermi in a 1941 conversation with his Chicago colleague Edward Teller. After this conversation, Teller (perhaps the model for Stanley Kubrick's character Dr. Strangelove) became a fanatical advocate of the superbomb.

After Truman's go-ahead, the American program to build thermonuclear weapons made rapid progress, and on October 31, 1952, the first US thermonuclear device was exploded at Eniwetok Atoll in the Pacific Ocean. It had a yield of 10.4 megatons, that is to say it had an explosive power equivalent to 10,400,000 tons of TNT. Thus the first thermonuclear bomb was five hundred times as powerful as the bombs that had devastated Hiroshima and Nagasaki. Lighter versions of the device were soon developed, and these could be dropped from aircraft or delivered by rockets.

The Soviet Union and the United Kingdom were not far behind. In 1955 the Soviets exploded their first thermonuclear device, followed in 1957 by the UK. In 1961 the USSR exploded a thermonuclear bomb with a yield of 58 megatons. A bomb of this size, three thousand times the size of the Hiroshima bomb, would be able to totally destroy a city even if it missed it by 50 kilometers. Fall-out casualties would extend to a far greater distance.

In the late 1950s General Gavin, Chief of Army Research and Development in the United States, was asked by the Symington Committee, "If we got into a nuclear war and our strategic air force made an assault in force against Russia with nuclear weapons exploded in a way where the prevailing winds would carry them south-east over Russia, what would be the effect in the way of death?"

General Gavin replied: "Current planning estimates run on the order of several hundred million deaths. That would be either way depending on which way the wind blew. If the wind blew to the south-east they would be mostly in the USSR, although they would extend into the Japanese area and perhaps down into the Philippine area. If the wind blew the other way, they would extend well back into Western Europe."

Between October 16 and October 28, 1962, the Cuban Missile Crisis occurred, an incident in which the world came extremely close to a full-scale thermonuclear war. During the crisis, President Kennedy and his advisers estimated that the chance of an all-out nuclear war with Russia was 50%. Recently-released documents indicate that the probability of war was even higher than Kennedy's estimate. Robert McNamara, who was Secretary of Defense at the time, wrote later, "We came within a hairbreadth of nuclear war without realizing it... Its no credit to us that we missed nuclear war..."

In 1964 the first Chinese nuclear weapon was tested, and this was followed in 1967 by a Chinese thermonuclear bomb with a yield of 3.3 megatons. France quickly followed suit testing a fission bomb in 1966 and a thermonuclear bomb in 1968. In all about thirty nations contemplated building nuclear weapons, and many made active efforts to do so.

Because the concept of deterrence required an attacked nation to be able to retaliate massively even though many of its weapons might be destroyed by a preemptive strike, the production of nuclear warheads reached insane heights, driven by the collective paranoia of the Cold War. More than 50,000 nuclear warheads were produced worldwide, a large number of them thermonuclear. The collective explosive power of these warheads was equivalent to 20,000,000,000 tons of TNT, i.e. 4 tons for every man, woman and child on the planet, or, expressed differently, a million times the explosive power of the bomb that destroyed Hiroshima.

The end of the Cold War

In 1985, Michael Gorbachev (1931-) became the General Secretary of the Communist Party of the Soviet Union. Gorbachev had become convinced by his conversations with scientists that the policy of nuclear confrontation between the United States and the USSR was far too dangerous to be continued over a long period of time. If continued, sooner or later, through accident of miscalculation, it would result in a disaster of unprecedented proportions. Gorbachev also believed that the USSR was in need of reform, and he introduced two words to characterize what he felt was needed: *glasnost* (openness) and *perestroika* (reconstruction).

In 1986, US President Ronald Reagan met Mikhail Gorbachev in Reykjavik, Iceland. The two leaders hoped that they might find ways of reducing the danger that a thermonuclear Third World War would be fought between their two countries. Donald Reagan, the White House Chief of Staff, was present at the meeting, and he records the following conversation: "At one point in time Gorbachev said 'I would like to do away with all nuclear weapons. And Reagan hit the table and said 'Well why didn't you say so in the first place! Thats exactly what I want to do! And if you want to do away with all the weapons, Ill agree to do away with all the weapons. Of course well do away with all the weapons. 'Good, [said Gorbachev] 'Thats great, but you must confine SDI to the laboratory. 'No I wont, said Reagan. 'No way. SDI continues. I told you that I am never going to give up SDI." The SDI program, which seemingly prevented Presidents Reagan and Gorbachev from reaching an agreement to completely eliminate their nuclear weapons was Reagan's "Star Wars" program which (in violation of the ABM Treaty) proposed to set up a system of of radar, satellites and missiles to shoot down attacking missiles.

Gorbachev s reforms effectively granted self-government to the various parts of the Soviet Union, and he himself soon resigned from his post as its leader, since the office was no longer meaningful. Most of the newly-independent parts of the old USSR began to introduce market economies, and an astonished world witnessed a series of unexpected and rapid changes: On September 10, 1989 Hungarian government opened its border for East German refugees; on November 9, 1989 Berlin Wall was reopened; on December 22, 1989 Brandenburg Gate was opened; and on October 3, 1990 Germany was reunited. The Cold War was over!

The Non-Proliferation Treaty

During the Cold War, a number of international treaties attempting to reduce the global nuclear peril had been achieved after much struggle. Among these, the 1968 Nuclear Non-Proliferation Treaty (NPT) has special importance. The NPT was designed to prevent the spread of nuclear weapons beyond the five nations that already had them; to provide assurance that "peaceful" nuclear activities of non-nuclear-weapon states would not be used to produce such weapons; to promote peaceful use of nuclear energy to the greatest extent consistent with non-proliferation of nuclear weapons; and finally, to ensure that definite steps towards complete nuclear disarmament would be taken by all states, as well steps towards comprehensive control of conventional armaments (Article VI).

The non-nuclear-weapon states insisted that Article VI be included in the treaty as a price for giving up their own ambitions. The full text of Article VI is as follows: "Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a Treaty on general and complete disarmament under strict international control."

The NPT has now been signed by 187 countries and has been in force as international law since 1970. However, Israel, India, Pakistan, and Cuba have refused to sign, and North Korea, after signing the treaty, withdrew from it in 1993. Israel began producing nuclear weapons in the late 1960s (with the help of a reactor provided by France) and the country is now believed to possess 100-150 of them, including neutron bombs. Israels policy is one of "nuclear opacity" - i.e., visibly possessing nuclear weapons while denying their existence.

South Africa, with the help of Israel and France, also produced nuclear weapons, which it tested in the Indian Ocean in 1979. In 1991 however, South Africa signed the NPT and destroyed its nuclear weapons.

India produced what it described as a "peaceful nuclear explosion" in 1974. By 1989 Indian scientists were making efforts to purify the lithium-6 isotope, a key component of the much more powerful thermonuclear bombs. In 1998, India conducted underground tests of nuclear weapons, and is now believed to have roughly 60 warheads, constructed from Pu-239 produced in "peaceful" reactors.

Pakistan's efforts to obtain nuclear weapons were spurred by India's 1974 "peaceful nuclear explosion". Zulfiquar Ali Bhutto, who initiated Pakistan's program, first as Minister of Fuel, Power and Natural Resources, and later as President and Prime Minister, declared: "There is a Christian Bomb, a Jewish Bomb and a Hindu Bomb. There must be an Islamic Bomb! We will get it even if we have to starve - even if we have to eat grass!" As early as 1970, the laboratory of Dr. Abdul Qadeer Khan, (a metallurgist who was to become Pakistan's leading nuclear bomb maker) had been able to obtain from a Dutch firm the high-speed ultracentrafuges needed for uranium enrichment. With unlimited financial support and freedom from auditing requirements, Dr. Khan purchased restricted items needed for nuclear weapon construction from companies in Europe and the United States. In the process, Dr. Khan became an extremely wealthy man. With additional help from China, Pakistan was ready to test five nuclear weapons in 1998. The Indian and Pakistani nuclear bomb tests, conducted in rapid succession, presented the world with the danger that these devastating bombs would be used in the conflict over Kashmir. Indeed, Pakistan announced that if a war broke out using conventional weapons, Pakistan's nuclear weapons would be used "at an early stage".

In Pakistan, Dr. A.Q. Khan became a great national hero. He was presented as the person who had saved Pakistan from attack by India by creating Pakistan's own nuclear weapons. In a Washington Post article[1] Pervez Hoodbhoy wrote: "Nuclear nationalism was the order of the day as governments vigorously promoted the bomb as the symbol of Pakistan's high scientific achievement and self-respect, and as the harbinger of a new Muslim era." Similar manifestations of nuclear nationalism could also be seen in India after India's 1998 bomb tests.

Early in 2004, it was revealed that Dr. Khan had for years been selling nuclear secrets and equipment to Lybia, Iran and North Korea. However, observers considered that it was unlikely that Khan would be tried for these offenses, since a trial might implicate Pakistan's army as well as two of its former

[1] 1 February, 2004

prime ministers. Furthermore, Dr. Khan has the strong support of Pakistan's Islamic fundamentalists. Recent assassinations emphasize the precariousness of Pakistan's government. There is a danger that it may be overthrown by Islamic fundamentalists, who would give Pakistan's nuclear weapons to terrorist organizations. This type of danger is a general one associated with nuclear proliferation. As more and more countries obtain nuclear weapons, it becomes increasingly likely that one of them will undergo a revolution, during the course of which nuclear weapons will fall into the hands of subnational organizations.

Article VIII of the Non-Proliferation Treaty provides for a conference to be held every five years to make sure that the NPT is operating as intended. In the 1995 NPT Review Conference, the lifetime of the treaty was extended indefinitely, despite the general dissatisfaction with the bad faith of the nuclear weapon states: They had dismantled some of their warheads but had taken no significant steps towards complete nuclear disarmament. The 2000 NPT Review Conference made it clear that the nuclear weapons states could not postpone indefinitely their commitment to nuclear disarmament by linking it to general and complete disarmament, since these are separate and independent goals of Article VI. The Final Document of the conference also contained 13 Practical Steps for Nuclear Disarmament, including ratification of a Comprehensive Test Ban Treaty (CTBT), negotiations on a Fissile Materials Cutoff Treaty, the preservation and strengthening of the Anti-Ballistic Missile (ABM) Treaty, greater transparency with regard to nuclear arsenals, and making irreversability a principle of nuclear reductions. Another review conference is scheduled for 2010, a year that marks the 55th anniversary of the destruction of Hiroshima and Nagasaki.

Something must be said about the concept of irreversability mentioned in the Final Document of the 2000 NPT Review Conference. Nuclear weapons can be destroyed in a completely irreversible way by getting rid of the special isotopes which they use. In the case of highly enriched uranium (HEU), this can be done by mixing it thoroughly with ordinary unenriched uranium. In natural uranium, the rare fissile isotope U-235 is only 0.7%. The remaining 99.3% consists of the common isotope, U-238, which under ordinary circumstances cannot undergo fission. If HEU is mixed with a sufficient quantity of natural uranium, so that the concentration of U-235 falls below 20%, it can no longer be used in nuclear weapons.

Getting rid of plutonium irreversibly is more difficult, but it could be cast into large concrete blocks and dumped into extremely deep parts of the ocean (e.g. the Japan Trench) where recovery would be almost impossible. Alternatively, it could be placed in the bottom of very deep mine shafts, which could afterwards be destroyed by means of conventional explosives. None of the strategic arms reduction treaties, neither the SALT treaties nor the 2002

Moscow Treaty, incorporate irreversability.

The recent recommendation by four distinguished German statesmen that all short-range nuclear weapons be destroyed is particularly interesting [13]. The strongest argument for the removal of US tactical nuclear weapons from Europe is the danger of collapse of the NPT. The 2005 NPT Review Conference was a disaster, and there is a danger that at the 2010 Review Conference, the NPT will collapse entirely because of the discriminatory position of the nuclear weapon states (NWS) and their failure to honor their commitments under Article VI. NATOs present nuclear weapon policy also violates the NPT, and correcting this violation would help to save the 2010 Review Conference from failure.

At present, the air forces of the European countries in which the US nuclear weapons are stationed perform regular training exercises in which they learn how to deliver the weapons. This violates the spirit, and probably also the letter, of Article IV, which prohibits the transfer of nuclear weapons from an NWS to a non-NWS. The "nuclear sharing" proponents maintain that such transfers would only happen in an emergency; but there is nothing in the NPT saying that the treaty would not hold under all circumstances. Furthermore, NATO would be improved, rather than damaged, by giving up "nuclear sharing". If President Obama wishes to fulfill his campaign promises [14] - if he wishes to save the NPT - a logical first step would be to remove US tactical nuclear weapons from Europe.

Flaws in the concept of nuclear deterrence

Before discussing other defects in the concept of deterrence, it must be said very clearly that the idea of "massive nuclear retaliation" is completely unacceptable from an ethical point of view. The doctrine of retaliation, performed on a massive scale, violates not only the principles of common human decency and common sense, but also the ethical principles of every major religion. Retaliation is especially contrary to the central commandment of Christianity which tells us to love our neighbor, even if he or she is far away from us, belonging to a different ethnic or political group, and even if our distant neighbor has seriously injured us. This principle has a fundamental place not only in in Christianity but also in Buddhism. "Massive retaliation" completely violates these very central ethical principles, which are not only clearly stated and fundamental but also very practical, since they prevent escalatory cycles of revenge and counter-revenge.

Contrast Christian ethics with estimates of the number of deaths that would follow a US nuclear strike against Russia: Several hundred million deaths. These horrifying estimates shock us not only because of the enormous magnitude of the expected mortality, but also because the victims would include people of every kind: women, men, old people, children and infants, completely irrespective of any degree of guilt that they might have. As a result of such an attack, many millions of people in neutral countries would also die. This type of killing has to be classified as genocide.

When a suspected criminal is tried for a wrongdoing, great efforts are devoted to clarifying the question of guilt or innocence. Punishment only follows if guilt can be proved beyond any reasonable doubt. Contrast this with the totally indiscriminate mass slaughter that results from a nuclear attack!

It might be objected that disregard for the guilt or innocence of victims is a universal characteristic of modern war, since statistics show that, with time, a larger and larger percentage of the victims have been civilians, and especially children. For example, the air attacks on Coventry during World War II, or the fire bombings of Dresden and Tokyo, produced massive casualties which involved all segments of the population with complete disregard for the question of guilt or innocence. The answer, I think, is that modern war has become generally unacceptable from an ethical point of view, and this unacceptability is epitomized in nuclear weapons.

The enormous and indiscriminate destruction produced by nuclear weapons formed the background for an historic 1996 decision by the International Court of Justice in the Hague. In response to questions put to it by WHO and the UN General Assembly, the Court ruled that "the threat and use of nuclear weapons would generally be contrary to the rules of international law applicable in armed conflict, and particularly the principles and rules of humanitarian law." The only *possible* exception to this general rule might be "an extreme circumstance of self-defense, in which the very survival of a state would be at stake". But the Court refused to say that even in this extreme circumstance the threat or use of nuclear weapons would be legal. It left the exceptional case undecided. In addition, the World Court added unanimously that "there exists an obligation to pursue in good faith *and bring to a conclusion* negotiations leading to nuclear disarmament in all its aspects under strict international control."

This landmark decision has been criticized by the nuclear weapon states as being decided "by a narrow margin", but the structuring of the vote made the margin seem more narrow than it actually was. Seven judges voted against Paragraph 2E of the decision (the paragraph which states that the threat or use of nuclear weapons would be generally illegal, but which mentions as a possible exception the case where a nation might be defending itself from an attack that threatened its very existence.) Seven judges voted for the paragraph, with the President of the Court, Muhammad Bedjaoui of Algeria casting the deciding vote. Thus the Court adopted it, seemingly by a narrow margin. But three of the judges who voted against 2E did so because they believed that no possible exception should be mentioned! Thus, if the vote had been slightly differently structured, the result would have be ten to four.

Of the remaining four judges who cast dissenting votes, three represented nuclear weapons states, while the fourth thought that the Court ought not to have accepted the questions from WHO and the UN. However Judge Schwebel from the United States, who voted against Paragraph 2E, nevertheless added, in a separate opinion, "It cannot be accepted that the use of nuclear weapons on a scale which would - or could - result in the deaths of many millions in indiscriminate inferno and by far-reaching fallout, have pernicious effects in space and time, and render uninhabitable much of the earth, could be lawful." Judge Higgins from the UK, the first woman judge in the history of the Court, had problems with the word "generally" in Paragraph 2E and therefore voted against it, but she thought that a more profound analysis might have led the Court to conclude in favor of illegality in all circumstances. Judge Fleischhauer of Germany said in his separate opinion, "The nuclear weapon is, in many ways, the negation of the humanitarian considerations underlying the law applicable in armed conflict and the principle of neutrality. The nuclear weapon cannot distinguish between civilian and military targets. It causes immeasurable suffering. The radiation released by it is unable to respect the territorial integrity of neutral States."

President Bedjaoui, summarizing the majority opinion, called nuclear weapons "the ultimate evil", and said "By its nature, the nuclear weapon, this blind weapon, destabilizes humanitarian law, the law of discrimination in the use of weapons... The ultimate aim of every action in the field of nuclear arms will always be nuclear disarmament, an aim which is no longer utopian and which all have a duty to pursue more actively than ever."

Thus the concept of nuclear deterrence is not only unacceptable from the standpoint of ethics; it is also contrary to international law. The World Courts 1996 advisory Opinion unquestionably also represents the opinion of the majority of the worlds peoples. Although no formal plebiscite has been taken, the votes in numerous resolutions of the UN General Assembly speak very clearly on this question. For example the New Agenda Resolution (53/77Y) was adopted by the General Assembly on 4 December 1998 by a massively affirmative vote, in which only 18 out of the 170 member states voted against the resolution.[2] The New Agenda Resolution proposes numerous practical steps towards complete nuclear disarmament, and it calls on the Nuclear-Weapon States "to demonstrate an unequivocal commitment to the speedy and to-

[2]Of the 18 countries that voted against the New Agenda resolution, 10 were Eastern European countries hoping for acceptance into NATO, whose votes seem to have been traded for increased probability of acceptance.

tal elimination of their nuclear weapons and without delay to pursue in good faith and bring to a conclusion negotiations leading to the elimination of these weapons, thereby fulfilling their obligations under Article VI of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)". Thus, in addition to being ethically unacceptable and contrary to international law, nuclear weapons also contrary to the principles of democracy.

Having said these important things, we can now turn to some of the other defects in the concept of nuclear deterrence. One important defect is that nuclear war may occur through accident or miscalculation - through technical defects or human failings. This possibility is made greater by the fact that despite the end of the Cold War, thousands of missiles carrying nuclear warheads are still kept on a "hair-trigger" state of alert with a quasi-automatic reaction time measured in minutes. There is a constant danger that a nuclear war will be triggered by error in evaluating the signal on a radar screen. For example, the BBC reported recently that a group of scientists and military leaders are worried that a small asteroid entering the earths atmosphere and exploding could trigger a nuclear war if mistaken for a missile strike.

A number of prominent political and military figures (many of whom have ample knowledge of the system of deterrence, having been part of it) have expressed concern about the danger of accidental nuclear war. Colin S. Grey[3] expressed this concern as follows: "The problem, indeed the enduring problem, is that we are resting our future upon a nuclear deterrence system concerning which we cannot tolerate even a single malfunction." General Curtis E. LeMay[4] has written, "In my opinion a general war will grow through a series of political miscalculations and accidents rather than through any deliberate attack by either side." Bruce G. Blair[5] has remarked that "It is obvious that the rushed nature of the process, from warning to decision to action, risks causing a catastrophic mistake."... "This system is an accident waiting to happen."

Today, the system that is supposed to give us security is called Mutually Assured Destruction, appropriately abbreviated as MAD. It is based on the idea of deterrence, which maintains that because of the threat of massive retaliation, no sane leader would start a nuclear war.

Before discussing other defects in the concept of deterrence, it must be said very clearly that the idea of "massive nuclear retaliation" is a form of genocide and is completely unacceptable from an ethical point of view. It violates not only the principles of common human decency and common sense, but also the ethical principles of every major religion.

Having said this, we can now turn to some of the other faults in the con-

[3]Chairman, National Institute for Public Policy
[4]Founder and former Commander in Chief of the United States Strategic Air Command
[5]Brookings Institute

cept of nuclear deterrence. One important defect is that nuclear war may occur through accident or miscalculation, through technical defects or human failings, or by terrorism. This possibility is made greater by the fact that despite the end of the Cold War, thousands of missiles carrying nuclear warheads are still kept on "hair-trigger alert" with a quasi-automatic reaction time measured in minutes. There is a constant danger that a nuclear war will be triggered by error in evaluating the signal on a radar screen.

Incidents in which global disaster is avoided by a hair's breadth are constantly occurring. For example, on the night of 26 September, 1983, Lt. Col. Stanislav Petrov, a young software engineer, was on duty at a surveillance center near Moscow. Suddenly the screen in front of him turned bright red.

An alarm went off. It's enormous piercing sound filled the room. A second alarm followed, and then a third, fourth and fifth. "The computer showed that the Americans had launched a strike against us", Petrov remembered later. His orders were to pass the information up the chain of command to Secretary General Yuri Andropov. Within minutes, a nuclear counterattack would be launched. However, because of certain inconsistent features of the alarm, Petrov disobeyed orders and reported it as a computer error, which indeed it was.

Most of us probably owe our lives to his coolheaded decision and knowledge of software systems. The narrowness of this escape is compounded by the fact that Petrov was on duty only because of the illness of another officer with less knowledge of software, who would have accepted the alarm as real.

Narrow escapes such as this show us clearly that in the long run, the combination of space-age science and stone-age politics will destroy us. We urgently need new political structures and new ethics to match our advanced technology. Modern science has, for the first time in history, offered humankind the possibility of a life of comfort, free from hunger and cold, and free from the constant threat of death through infectious disease. At the same time, science has given humans the power to obliterate their civilization with nuclear weapons, or to make the earth uninhabitable through overpopulation and pollution. The question of which of these paths we choose is literally a matter of life or death for ourselves and our children.

Will we use the discoveries of modern science constructively, and thus choose the path leading towards life? Or will we use science to produce more and more lethal weapons, which sooner or later, through a technical or human failure, will result in a catastrophic nuclear war? Will we thoughtlessly destroy our beautiful planet through unlimited growth of population and industry? The choice among these alternatives is ours to make. We live at a critical moment of history, a moment of crisis for civilization.

No one alive today asked to be born at a time of crisis, but history has given each of us an enormous responsibility. Of course we have our ordinary jobs, which we need to do in order to stay alive; but besides that, each of us has a second job, the duty to devote both time and effort to solving the serious problems that face civilization during the 21st century. We cannot rely on our politicians to do this for us. Many politicians are under the influence of powerful lobbies. Others are waiting for a clear expression of popular will. It is the people of the world themselves who must choose their own future and work hard to build it.

No single person can achieve the changes that we need, but together we can do it. The problem of building a stable, just, and war-free world is difficult, but it is not impossible. The large regions of our present-day world within which war has been eliminated can serve as models. There are a number of large countries with heterogeneous populations within which it has been possible to achieve internal peace and social cohesion, and if this is possible within such extremely large regions, it must also be possible globally.

We must replace the old world of international anarchy, chronic war, and institutionalized injustice by a new world of law. The United Nations Charter, the Universal Declaration of Human Rights and the International Criminal Court are steps in the right direction. These institutions need to be greatly strengthened and reformed. We also need a new global ethic, where loyalty to one's family and nation will be supplemented by a higher loyalty to humanity as a whole. Tipping points in public opinion can occur suddenly. We can think, for example, of the Civil Rights Movement, or the rapid fall of the Berlin Wall, or the sudden change that turned public opinion against smoking, or the sudden movement for freedom and democracy in the Arab world. A similar sudden change can occur soon regarding war and nuclear weapons.

We know that war is madness. We know that it is responsible for much of the suffering that humans experience. We know that war pollutes our planet and that the almost unimaginable sums wasted on war prevent the happiness and prosperity of mankind. We know that nuclear weapons are insane, and that the precariously balanced deterrence system can break down at any time through human error or computer errors or through terrorist actions, and that it definitely will break down within our lifetimes unless we abolish it. We know that nuclear war threatens to destroy civilization and much of the biosphere.

The logic is there. We must translate into popular action which will put an end to the undemocratic, money-driven, power-lust-driven war machine. The peoples of the world must say very clearly that nuclear weapons are an absolute evil; that their possession does not increase anyone's security; that their continued existence is a threat to the life of every person on the planet; and that these genocidal and potentially omnicidal weapons have no place in a civilized society.

Modern science has abolished time and distance as factors separating nations. On our shrunken globe today, there is room for one group only: the family of humankind. We must embrace all other humans as our brothers and sisters. More than that, we must feel that all of nature is part of the same sacred family; meadow flowers, blowing winds, rocks, trees, birds, animals, and other humans, all these are our brothers and sisters, deserving our care and protection. Only in this way can we survive together. Only in this way can we build a happy future.

"But nobody can predict that the fatal accident or unauthorized act will never happen", Fred Ikle of the Rand Corporation has written, "Given the huge and far-flung missile forces, ready to be launched from land and sea on on both sides, the scope for disaster by accident is immense... In a matter of seconds - through technical accident or human failure - mutual deterrence might thus collapse."

Another serious failure of the concept of nuclear deterrence is that it does not take into account the possibility that atomic bombs may be used by terrorists. Indeed, the threat of nuclear terrorism has today become one of the most pressing dangers that the world faces, a danger that is particularly acute in the United States.

Since 1945, more than 3,000 metric tons (3,000,000 kilograms) of highly enriched uranium and plutonium have been produced - enough for several hundred thousand nuclear weapons. Of this, roughly a million kilograms are in Russia, inadequately guarded, in establishments where the technicians are poorly paid and vulnerable to the temptations of bribery. There is a continuing danger that these fissile materials will fall into the hands of terrorists, or organized criminals, or irresponsible governments. Also, an extensive black market for fissile materials, nuclear weapons components etc. has recently been revealed in connection with the confessions of Pakistan's bomb-maker, Dr. A.Q. Khan. Furthermore, if Pakistan's less-than-stable government should be overthrown, complete nuclear weapons could fall into the hands of terrorists.

On November 3, 2003, Mohamed ElBaradei, Director General of the International Atomic Energy Agency, made a speech to the United Nations in which he called for "limiting the processing of weapons-usable material (separated plutonium and high enriched uranium) in civilian nuclear programmes - as well as the production of new material through reprocessing and enrichment - by agreeing to restrict these operations to facilities exclusively under international control." It is almost incredible, considering the dangers of nuclear proliferation and nuclear terrorism, that such restrictions were not imposed long ago. Nuclear reactors used for "peaceful" purposes unfortunately also generate fissionable isotopes of plutonium, neptunium and americium. Thus all nuclear reactors must be regarded as ambiguous in function, and all must

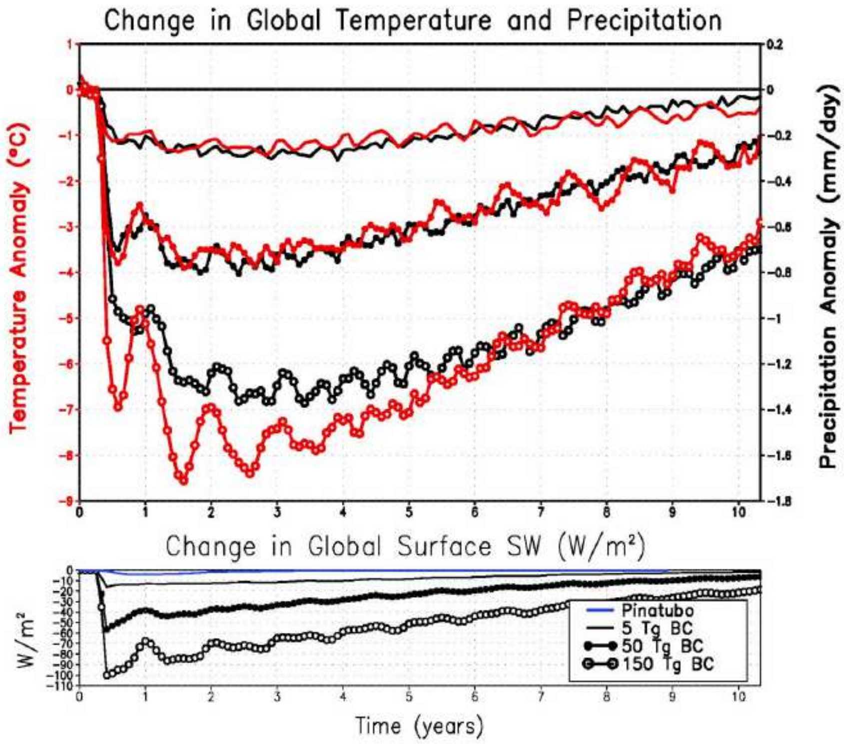

Figure 5.13: *Recent studies by atmospheric scientists have shown that the smoke from burning cities produced by even a limited nuclear war would have a devastating effect on global agriculture. The studies show that the smoke would rise to the stratosphere, where it would spread globally and remain for a decade, blocking sunlight and destroying the ozone layer. Because of the devastating effect on global agriculture, darkness from even a small nuclear war (e.g. between India and Pakistan) would result in an estimated billion deaths from famine.* (O. Toon, A. Robock and R. Turco, "The Environmental Consequences of Nuclear War", Physics Today, vol. 61, No. 12, 2008, p. 37-42)

be put under strict international control. One might ask, in fact, whether globally widespread use of nuclear energy is worth the danger that it entails.

The Italian nuclear physicist Francesco Calogero, who has studied the matter closely, believes that terrorists could easily construct a simple gun-type nuclear bomb if they were in possession of a critical mass of highly enriched uranium. In such a simple atomic bomb, two grapefruit-sized subcritical portions of HEU are placed at opposite ends of the barrel of an artillery piece and are driven together by means of a conventional explosive. Prof. Calogero estimates that the fatalities produced by the explosion of such a device in the center of a large city could exceed 100,000.

We must remember the remark of U.N. Secretary General Kofi Annan after the 9/11/2001 attacks on the World Trade Center. He said, "*This time* it was not a nuclear explosion". The meaning of his remark is clear: If the world does not take strong steps to eliminate fissionable materials and nuclear weapons, it will only be a matter of time before they will be used in terrorist attacks on major cities. Neither terrorists nor organized criminals can be deterred by the threat of nuclear retaliation, since they have no territory against which such retaliation could be directed. They blend invisibly into the general population. Nor can a "missile defense system" prevent terrorists from using nuclear weapons, since the weapons can be brought into a port in any one of the hundreds of thousands of containers that enter on ships each year, a number far too large to be checked exhaustively.

In this dangerous situation, the only logical thing for the world to do is to get rid of both fissile materials and nuclear weapons as rapidly as possible. We must acknowledge that the idea of nuclear deterrence is a dangerous fallacy, and acknowledge that the development of military systems based on nuclear weapons has been a terrible mistake, a false step that needs to be reversed. If the most prestigious of the nuclear weapons states can sincerely acknowledge their mistakes and begin to reverse them, nuclear weapons will seem less glamorous to countries like India, Pakistan, North Korea and Iran, where they now are symbols of national pride and modernism.

Civilians have for too long played the role of passive targets, hostages in the power struggles of politicians. It is time for civil society to make its will felt. If our leaders continue to enthusiastically support the institution of war, if they will not abolish nuclear weapons, then let us have new leaders.

Establishment opinion shifts towards nuclear abolition

Today there are indications that the establishment is moving towards the point of view that the peace movement has always held: - that nuclear weapons are essentially genocidal, illegal and unworthy of civilization; and that they must be completely abolished as quickly as possible. There is a rapidly-growing global consensus that a nuclear-weapon-free world can and must be achieved in the very near future.

One of the first indications of the change was the famous Wall Street Journal article by Schultz, Perry, Kissinger and Nunn advocating complete abolition of nuclear arms [1]. This was followed quickly by Mikhail Gorbachev's supporting article, published in the same journal [2], and a statement by distinguished Italian statesmen [3]. Meanwhile, in October 2007, the Hoover Institution had arranged a symposium entitled "Reykjavik Revisited; Steps Towards a World Free of Nuclear Weapons" [4].

In Britain, Sir Malcolm Rifkind, Lord Hurd and Lord Owen (all former Foreign Secretaries) joined the former NATO Secretary General Lord Robertson as authors of an article in The Times advocating complete abolition of nuclear weapons [5]. The UK's Secretary of State for Defense, Des Brown, speaking at a disarmament conference in Geneva, proposed that the UK "host a technical conference of P5 nuclear laboratories on the verification of nuclear disarmament before the next NPT Review Conference in 2010" to enable the nuclear weapon states to work together on technical issues.

In February, 2008, the Government of Norway hosted an international conference on "Achieving the Vision of a World Free of Nuclear Weapons" [7]. A week later, Norway's Foreign Minister, Jonas Gahr Støre, reported the results of the conference to a disarmament meeting in Geneva [8]. On July 11, 2008 , speaking at a Pugwash Conference in Canada, Norway's Defense Minister, Anne-Grete Strøm-Erichsen, reiterated her country's strong support for the complete abolition of nuclear weapons [9].

In July 2008, Barack Obama said in his Berlin speech, "It is time to secure all loose nuclear materials; to stop the spread of nuclear weapons; and to reduce the arsenals from another era. This is the moment to begin the work of seeking the peace of a world without nuclear weapons."

Later that year, in September, Vladimir Putin said, "Had I been told just two or three years ago I wouldn't believe that it would be possible, but I believe that it is now quite possible to liberate humanity from nuclear weapons..."

Other highly-placed statesmen added their voices to the growing consensus: Australia's Prime Minister, Kevin Rudd, visited the Peace Museum at Hiroshima, where he made a strong speech advocating nuclear abolition. He later set up an International Commission on Nuclear Non-Proliferation and Disarmament co-chaired by Australia and Japan [10].

On January 9, 2009, four distinguished German statesmen (Richard von Weizäcker, Helmut Schmidt, Egon Bahr and Hans-Dietrich Genscher) published an article entitled "Towards a Nuclear-Free World: a German View" in the International Herald Tribune [12]. Among the immediate steps recommended in the article are the following:

- The vision of a nuclear-weapon-free world... must be rekindled.
- Negotiations aimed at drastically reducing the number of nuclear weapons must begin...
- The Nuclear Non-Proliferation Treaty (NPT) must be greatly reinforced.
- America should ratify the Comprehensive Nuclear Test-Ban Treaty.
- All short-range nuclear weapons must be destroyed.
- The Anti-Ballistic Missile (ABM) Treaty must be restored. Outer space may only be used for peaceful purposes.

Going to zero

On December 8-9, 2008, approximately 100 international leaders met in Paris to launch the Global Zero Campaign [11]. They included Her Majesty Queen Noor of Jordan, Norway's former Prime Minister Gro Harlem Brundtland, former UK Foreign Secretaries Sir Malcolm Rifkind, Margaret Beckett and David Owen, Ireland's former Prime Minister Mary Robinson, UK philanthropist Sir Richard Branson, former UN Under-Secretary-General Jayantha Dhanapala, and Nobel Peace Prize winners President Jimmy Carter, President Mikhail Gorbachev, Archbishop Desmond Tutu and Prof. Muhammad Yunus. The concrete steps advocated by Global Zero include:

- Deep reductions to Russian-US arsenals, which comprise 96% of the worlds 27,000 nuclear weapons.
- Russia and the United States, joined by other nuclear weapons states, cutting arsenals to zero in phased and verified reductions.
- Establishing verification systems and international management of the fuel cycle to prevent future development of nuclear weapons.

The Global Zero website [11] contains a report on a new public opinion poll covering 21 nations, including all of the nuclear weapons states.The poll showed that public opinion overwhelmingly favors an international agreement for eliminating all nuclear weapons according to a timetable. It was specified that the agreement would include monitoring. The average in all countries of the percent favoring such an agreement was 76%. A few results of special interest mentioned in the report are Russia 69%; the United States, 77%; China, 83%; France, 86%, and Great Britain, 81%.

In his April 5, 2009 speech in Prague the newly-elected U.S. President Barack Obama said: "To reduce our warheads and stockpiles, we will negotiate a new strategic arms reduction treaty with Russia this year. President Medvedev and I will begin this process in London, and we will seek an agreement by the end of the year that is sufficiently bold. This will set the stage for further cuts, and we will seek to involve all nuclear weapon states in this endeavor... To achieve a global ban on nuclear testing, my administration will immediately and aggressively pursue U.S. ratification of the Comprehensive Test Ban Treaty."

A few days later, on April 24, 2009, the European Parliament recommended complete nuclear disarmament by 2020. An amendment introducing the "Model Nuclear Weapons Convention" and the "Hiroshima-Nagasaki Protocol" as concrete tools to achieve a nuclear weapons free world by 2020 was approved with a majority of 177 votes against 130. The Nuclear Weapons Convention is analogous to the conventions that have successfully banned chemical and biological weapons.

The role of public opinion

Public opinion is extremely important for the actual achievement of complete nuclear abolition. In the first place, the fact that the public is overwhelmingly against the retention of nuclear weapons means that the continuation of nuclear arsenals violates democratic principles. Secondly, the weapons are small enough to be easily hidden. Therefore the help of "whistle-blowers" will be needed to help inspection teams to make sure that no country violates its agreement to irreversibly destroy every atomic bomb. What is needed is a universal recognition that nuclear weapons are an absolute evil, and that their continued existence is a threat to human civilization and to the life of every person on the planet.

Our aim must be to delegitimize nuclear weapons, in much the same way that unnecessary greenhouse gas emissions have recently been delegitimized, or cigarette smoking delegitemized, or racism delegitemized. This should be an easy task because of the essentially genocidal nature of nuclear weapons. For half a century, ordinary people have been held as hostages, never knowing from day to day whether their own lives and the lives of those they love would suddenly be sacrificed on the alter of thermonuclear nationalism and power politics. We must let the politicians know that we are no longer willing to be hostages; and we must also accept individual responsibility for reporting violations of international treaties, although our own nation might be the violator.

Most of us grew up in schools where we were taught that duty to our

Figure 5.14: *Women Strike for Peace during the Cuban Missile Crisis in 1962.*(Public domain)

nation was the highest duty; but the times we live in today demand a change of heart, a higher loyalty to humanity as a whole. If the mass media cooperate in delegitimizing nuclear weapons, if educational systems cooperate and if religions [6] cooperate, the change of heart that we need - the global ethic that we need - can quickly be achieved.

Complete abolition of nuclear weapons

Although the Cold War has ended, the danger of a nuclear catastrophe is greater today than ever before. There are almost 16,000 nuclear weapons in

[6] As an example of the role that religions can play, we can consider the Buddhist organization Soka Gakkai International (SGI), which has 12 million members throughout the world. SGIs President Daisaku Ikeda has declared nuclear weapons to be an absolute evil and for more than 50 years the organization has worked for their abolition.

the world today, of which more than 90 percent are in the hands of Russia and the United States. About 2,000 of these weapons are on hair-trigger alert, meaning that whoever is in charge of them has only a few minutes to decide whether the signal indicating an attack is real, or an error. The most important single step in reducing the danger of a disaster would be to take all weapons off hair-trigger alert.

Bruce G. Blair, Brookings Institute, has remarked "It is obvious that the rushed nature of the process, from warning to decision to action, risks causing a catastrophic mistake... This system is an accident waiting to happen." Fred Ikle of the Rand Corporation has written,' 'But nobody can predict that the fatal accident or unauthorized act will never happen. Given the huge and far-flung missile forces, ready to be launched from land and sea on on both sides, the scope for disaster by accident is immense... In a matter of seconds, through technical accident or human failure, mutual deterrence might thus collapse."

Although their number has been substantially reduced from its Cold War maximum, the total explosive power of todays weapons is equivalent to roughly half a million Hiroshima bombs. To multiply the tragedy of Hiroshima and Nagasaki by a factor of half a million changes the danger qualitatively. What is threatened today is the complete breakdown of human society.

There is no defense against nuclear terrorism. We must remember the remark of U.N. Secretary General Kofi Annan after the 9/11/2001 attacks on the World Trade Center. He said, ' 'This time it was not a nuclear explosion". The meaning of his remark is clear: If the world does not take strong steps to eliminate fissionable materials and nuclear weapons, it will only be a matter of time before they will be used in terrorist attacks on major cities. Neither terrorists nor organized criminals can be deterred by the threat of nuclear retaliation, since they have no territory against which such retaliation could be directed. They blend invisibly into the general population. Nor can a "missile defense system" prevent terrorists from using nuclear weapons, since the weapons can be brought into a port in any one of the hundreds of thousands of containers that enter on ships each year, a number far too large to be checked exhaustively.

As the number of nuclear weapon states grows larger, there is an increasing chance that a revolution will occur in one of them, putting nuclear weapons into the hands of terrorist groups or organized criminals. Today, for example, Pakistans less-than-stable government might be overthrown, and Pakistans nuclear weapons might end in the hands of terrorists. The weapons might then be used to destroy one of the worlds large coastal cities, having been brought into the port by one of numerous container ships that dock every day. Such an event might trigger a large-scale nuclear conflagration.

Today, the world is facing a grave danger from the reckless behavior of the government of the United States, which recently arranged a coup that overthrew the elected government of Ukraine. Although Victoria Nulands December 13, 2013 speech talks much about democracy, the people who carried out the coup in Kiev can hardly be said to be democracy's best representatives. Many belong to the Svoboda Party, which had its roots in the Social-National Party of Ukraine (SNPU). The name was an intentional reference to the Nazi Party in Germany.

It seems to be the intention of the US to establish NATO bases in Ukraine, no doubt armed with nuclear weapons. In trying to imagine how the Russians feel about this, we might think of the US reaction when a fleet of ships sailed to Cuba in 1962, bringing Soviet nuclear weapons. In the confrontation that followed, the world was bought very close indeed to an all-destroying nuclear war. Does not Russia feel similarly threatened by the thought of hostile nuclear weapons on its very doorstep? Can we not learn from the past, and avoid the extremely high risks associated with the similar confrontation in Ukraine today?

In general, aggressive interventions, in Iran, Syria, Ukraine, the Korean Peninsula and elsewhere, all present dangers for uncontrollable escalation into large and disastrous conflicts, which might potentially threaten the survival of human civilization.

Few politicians or military figures today have any imaginative understanding of what a war with thermonuclear weapons would be like. Recent studies have shown that in a nuclear war, the smoke from firestorms in burning cities would rise to the stratosphere where it would remain for a decade, spreading throughout the world, blocking sunlight, blocking the hydrological cycle and destroying the ozone layer. The effect on global agriculture would be devastating, and the billion people who are chronically undernourished today would be at risk. Furthermore, the tragedies of Chernobyl and Fukushima remind us that a nuclear war would make large areas of the world permanently uninhabitable because of radioactive contamination. A full-scale thermonuclear war would be the ultimate ecological catastrophe. It would destroy human civilization and much of the biosphere.

One can gain a small idea of the terrible ecological consequences of a nuclear war by thinking of the radioactive contamination that has made large areas near to Chernobyl and Fukushima uninhabitable, or the testing of hydrogen bombs in the Pacific, which continues to cause cancer, leukemia and birth defects in the Marshall Islands more than half a century later.

The United States tested a hydrogen bomb at Bikini in 1954. Fallout from the bomb contaminated the island of Rongelap, one of the Marshall Islands 120 kilometers from Bikini. The islanders experienced radiation illness, and many died from cancer. Even today, half a century later, both people and animals on Rongelap and other nearby islands suffer from birth defects. The most common defects have been ‘ ‘jelly fish babies”, born with no bones and with transparent skin. Their brains and beating hearts can be seen. The babies usually live a day or two before they stop breathing.

A girl from Rongelap describes the situation in the following words: ‘ ‘I cannot have children. I have had miscarriages on seven occasions... Our culture and religion teach us that reproductive abnormalities are a sign that women have been unfaithful. For this reason, many of my friends keep quiet about the strange births that they have had. In privacy they give birth, not to children as we like to think of them, but to things we could only describe as octopuses, apples, turtles and other things in our experience. We do not have Marshallese words for these kinds of babies, because they were never born before the radiation came.”

The Republic of the Marshall Islands is suing the nine countries with nuclear weapons at the International Court of Justice at The Hague, arguing they have violated their legal obligation to disarm. The Guardian reports that ‘ ‘In the unprecedented legal action, comprising nine separate cases brought before the ICJ on Thursday, the Republic of the Marshall Islands accuses the nuclear weapons states of a ‘flagrant denial of human justice. It argues it is justified in taking the action because of the harm it suffered as a result of the nuclear arms race.

The Pacific chain of islands, including Bikini Atoll and Enewetak, was the site of 67 nuclear tests from 1946 to 1958, including the Bravo shot, a 15-megaton device equivalent to a thousand Hiroshima blasts, detonated in 1954. The Marshallese islanders say they have been suffering serious health and environmental effects ever since.

The island republic is suing the five ‘established nuclear weapons states recognized in the 1968 nuclear non-proliferation treaty (NPT), the US, Russia (which inherited the Soviet arsenal), China, France and the UK, as well as the three countries outside the NPT who have declared nuclear arsenals: India, Pakistan and North Korea, and the one undeclared nuclear weapons state, Israel. The Republic of the Marshall Islands is not seeking monetary compensation, but instead it seeks to make the nuclear weapon states comply with their legal obligations under Article VI of the Nuclear Nonproliferation Treaty and the 1996 ruling of the International Court of Justice.

The Nuclear Age Peace Foundation (NAPF) is a consultant to the Marshall Islands on the legal and moral issues involved in bringing this case. David Krieger, President of NAPF, upon hearing of the motion to dismiss the case by the U.S. responded, ‘ ‘The U.S. government is sending a terrible message to the world, that is, that U.S. courts are an improper venue for resolving disputes with other countries on U.S. treaty obligations. The U.S. is, in effect, saying that whatever breaches it commits are all right if it says so. That is bad for the law, bad for relations among nations, bad for nuclear non-proliferation and disarmament, and not only bad, but extremely dangerous for U.S. citizens and all humanity."

The RMI has appealed the U.S. attempt to reject its suit in the U.S, Federal Court, and it will continue to sue the nine nuclear nations in the International Court of Justice. Whether or not the suits succeed in making the nuclear nations comply with international law, attention will be called to the fact the nine countries are outlaws. In vote after vote in the United Nations General Assembly, the peoples of the world have shown how deeply they long to be free from the menace of nuclear weapons. Ultimately, the tiny group of power-hungry politicians must yield to the will of the citizens whom they are at present holding as hostages.

It is a life-or-death question. We can see this most clearly when we look far ahead. Suppose that each year there is a certain finite chance of a nuclear catastrophe, let us say 2 percent. Then in a century the chance of survival will be 13.5 percent, and in two centuries, 1.8 percent, in three centuries, 0.25 percent, in 4 centuries, there would only be a 0.034 percent chance of survival and so on. Over many centuries, the chance of survival would shrink almost to zero. Thus by looking at the long-term future, we can clearly see that if nuclear weapons are not entirely eliminated, civilization will not survive.

Civil society must make its will felt. A thermonuclear war today would be not only genocidal but also omnicidal. It would kill people of all ages, babies, children, young people, mothers, fathers and grandparents, without any regard whatever for guilt or innocence. Such a war would be the ultimate ecological catastrophe, destroying not only human civilization but also much of the biosphere. Each of us has a duty to work with dedication to prevent it.

One important possibility for progress on the seemingly intractable issue of nuclear disarmament would be for a nation or group of nations to put forward a proposal for a Nuclear Weapons Convention for direct vote on the floor of the UN General Assembly. It would almost certainly be adopted by a massive majority. I believe that such a step would be a great achievement, even if bitterly opposed by some of the nuclear weapons states. When the will of the majority of the worlds peoples is clearly expressed in an international treaty, even if the treaty functions imperfectly, the question of legality is clear. Everyone can see which states are violating international law. In time, world public opinion will force the criminal states to conform with international law.

In the case of a Nuclear Weapons Convention, world public opinion would have especially great force. It is generally agreed that a full-scale nuclear war would have disastrous effects, not only on belligerent nations but also on neutral countries. Mr. Javier Pérez de Cuéllar , former Secretary-General of the United Nations, emphasized this point in one of his speeches: "I feel", he said, ' 'that the question may justifiably be put to the leading nuclear powers: by what right do they decide the fate of humanity? From Scandinavia to Latin America, from Europe and Africa to the Far East, the destiny of every man and woman is affected by their actions. No one can expect to escape from the catastrophic consequences of a nuclear war on the fragile structure of this planet. ..."

' 'No ideological confrontation can be allowed to jeopardize the future of humanity. Nothing less is at stake: todays decisions affect not only the present; they also put at risk succeeding generations. Like supreme arbiters, with our disputes of the moment, we threaten to cut off the future and to extinguish the lives of innocent millions yet unborn. There can be no greater arrogance. At the same time, the lives of all those who lived before us may be rendered meaningless; for we have the power to dissolve in a conflict of hours or minutes the entire work of civilization, with all the brilliant cultural heritage of humankind.

"...In a nuclear age, decisions affecting war and peace cannot be left to military strategists or even to governments. They are indeed the responsibility of every man and woman. And it is therefore the responsibility of all of us... to break the cycle of mistrust and insecurity and to respond to humanity's yearning for peace."

The eloquent words of Javier Pérez de Cuéllar express the situation in which we now find ourselves: Accidental nuclear war, nuclear terrorism, insanity of a person in a position of power, or unintended escalation of a conflict, could at any moment plunge our beautiful world into a catastrophic thermonuclear war which might destroy not only human civilization but also much of the biosphere.

A model Nuclear Weapons Convention already exists. It was drafted in 1996 and updated in 2007 by three NGOs: International Association of Lawyers Against Nuclear Arms, International Network of Engineers and Scientists Against Nuclear Proliferation and International Physicians for the Prevention of Nuclear War. The Nuclear Weapons Convention (NWC) can be downloaded in many languages from the website of Unfold Zero. It could be put to a direct vote at the present session of the UN General Assembly. The mechanism for doing this could exactly parallel the method by which the Arms Trade Treaty was adopted in 2013. The UN Ambassador of Costa Rica could send a copy of the NWC to Secretary General Ban Ki-moon, asking him, on behalf of Costa Rica, Mexico and Austria to put it to a swift vote in the General Assembly.

There is strong evidence that the NWC would be passed by a large majority. For example, Humanitarian Initiative Joint Statement of 2015 was endorsed by 159 governments. Furthermore, the consensus document of the NPT Review Conference of 2010, endorsed by 188 state parties, contains the following sentence: ' 'The Conference expresses its deep concern at the humanitarian consequences of any use of nuclear weapons and reaffirms the need for all States at all times to comply with applicable international law, including international humanitarian law".

We can expect that the adoption of a Nuclear Weapons Convention will be opposed by the states that currently possess these weapons. One reason for this is the immense profits that suppliers make by ' 'modernizing" nuclear arsenals. For example, the Arms Control Association states ' 'The U.S. military is in the process of modernizing all of its existing strategic delivery systems and refurbishing the warheads they carry to last for the next 30-50 years." It adds ' 'Three independent estimates put the expected total cost over the next 30 years at as much as $1 trillion." We should notice that these plans for long-term retention of nuclear weapons are blatant violations of Article VI of the NPT.

Money is often the motive for crimes, and in this case, a vast river of money is driving us in the direction of a catastrophic nuclear war. If we wait for the approval of the nuclear weapon states, we will have to wait forever, and the general public, whose active help we need in abolishing nuclear weapons, will feel more and more helpless and powerless. To prevent this, we need concrete progress rather than endless delay.

There are strong precedents for the adoption of the NWC against the opposition of powerful states. The Arms Trade Treaty is one precedent, the International Criminal Court is another and the Ottawa Treaty is a third.

The adoption of an Arms Trade Treaty is a great step forward; the adoption of the ICC, although its operation is imperfect, is also a great step forward, and likewise, the Antipersonnel Land-Mine Convention is a great step forward. In my opinion, the adoption of a Nuclear Weapons Convention, even in the face of powerful opposition, would also be a great step forward. When the will of the majority of the worlds peoples is clearly expressed in an international treaty, even if the treaty functions imperfectly, the question of legality is clear. Everyone can see which states are violating international law. In time, world public opinion will force the criminal states to conform to the law.

Figure 5.15: *Fireball of the Tsar Bomba (RDS-220), the largest weapon ever detonated (1961). Fission-fusion-fission bombs of almost unlimited power can be constructed by adding a layer of inecpensive ordinary uranium outside a core containing a fission-fusion bomb. Such a bomb would completely destroy a city even if it missed the target by 50 kilometers.* (Fair use: “Tsar Bomba”, Wikipedia)

In the world as it is, the nuclear weapons now stockpiled are sufficient to kill everyone on earth several times over. Nuclear technology is spreading, and many politically unstable countries have recently acquired nuclear weapons or may acquire them soon. Even terrorist groups or organized criminals may acquire such weapons, and there is an increasing danger that they will be used.

In the world as it could be, both the manufacture and the possession of nuclear weapons would be prohibited. The same would hold for other weapons of mass destruction.

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Chapter 6

THE DEVIL'S DYNAMO

Why is the military-industrial complex sometimes called "The Devil's Dynamo"?

The military-industrial complex involves a circular flow of money. The money flows like the electrical current in a dynamo, driving a diabolical machine. Money from immensely rich corporate oligarchs buys the votes of politicians and the propaganda of the mainstream media. Numbed by the propaganda, citizens allow the politicians to vote for obscenely bloated military budgets, which further enrich the corporate oligarchs, and the circular flow continues.

The Industrial Revolution and Colonialism

The devil's dynamo of today has lead to a modern version of colonialism and empire. It is therefore interesting to look at the first global era of colonialism: In the 18th and 19th centuries, the continually accelerating development of science and science-based industry began to affect the whole world. As the factories of Europe poured out cheap manufactured goods, a change took place in the patterns of world trade: Before the Industrial Revolution, trade routes to Asia had brought Asian spices, textiles and luxury goods to Europe. For example, cotton cloth and fine textiles, woven in India, were imported to England. With the invention of spinning and weaving machines, the trade was reversed. Cheap cotton cloth, manufactured in England, began to be sold in India, and the Indian textile industry withered, just as the hand-loom industry in England itself had done a century before.

The rapid development of technology in the west also opened an enormous gap in military strength between the industrialized nations and the rest of the world. Taking advantage of their superior weaponry, the advanced industrial nations rapidly carved the remainder of the world into colonies, which

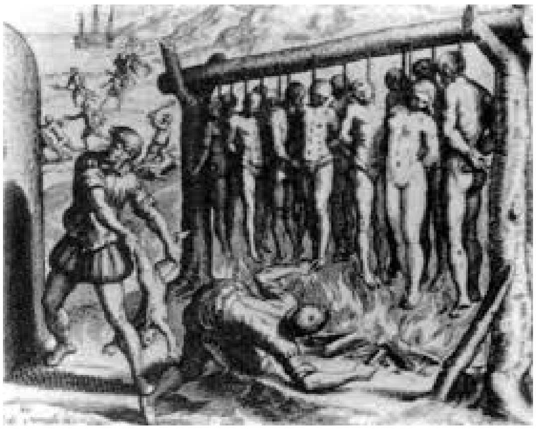

Figure 6.1: *The "Conquistadors" in Central and South America exhibited almost unbelievable treachery and cruelty towards the people of the region.*

acted as sources of raw materials and food, and as markets for manufactured goods. Throughout the American continent, the native Indian population had proved vulnerable to European diseases, such as smallpox, and large numbers of them had died. The remaining Indians were driven westward by streams of immigrants arriving from Europe.

The sometimes genocidal wars waged by industrial nations against the inhabitants of Asia, Africa and the Western Hemisphere often involved almost unimaginable cruelty. We can think, for example of the atrocities committed by the army of Leopold II in Belgian Congo, where more than ten million people were killed out of a total population of 20 million. (In Leopold's Congo human hands became a sort of currency. This was because the men in Leopold's army were ordered to cut off the hands of their victims to prove that they had not wasted bullets.) We can also think of distribution of smallpox-infected blankets to the Amerinds, or the unbelievable treachery and cruelty of Conquistadors in Central America and South South America.

Often the industrialized nations made their will felt by means of naval bombardments: In 1854, Commodore Perry forced Japan to accept foreign traders by threatening to bombard Tokyo. In 1856, British warships bombarded Canton in China to punish acts of violence against Europeans living in the city. In 1864, a force of European and American warships bombarded Choshu in Japan, causing a revolution. In 1882, Alexandria was bombarded, and in 1896, Zanzibar.

Much that was beautiful and valuable was lost, as mature traditional cultures collapsed, overcome by the power and temptations of modern industrial civilization. For the Europeans and Americans of the late 19th century and early 20th century, progress was a religion, and imperialism was its crusade.

Figure 6.2: *A map showing colonies at the end of the 19th century*

Figure 6.3: *"Whatever happens, we have got The Maxim gun, and they have not"*

Between 1800 and 1875, the percentage of the earth's surface under European rule increased from 35percent to 67 percent. In the period between 1875 and 1914, there was a new wave of colonial expansion, and the fraction of the earth's surface under the domination of colonial powers (Europe, the United States and Japan) increased to 85 percent, if former colonies are included.

The unequal (and unfair) contest between the industrialized countries, armed with modern weapons, and the traditional cultures with their much more primitive arms, was summarized by the English poet Hilaire Belloc in a sardonic couplet: "Whatever happens, we have got The Maxim gun, and they have not."

The Maxim gun was one of the world's first automatic machine guns. It was invented in the United States in 1884 by Hiram S. Maxim. The explorer and colonialist Henry Morton Stanley (1841-1904) was extremely enthusiastic about Maxim's machine gun, and during a visit to the inventor he tried firing it, demonstrating that it really could fire 600 rounds per minute. Stanley commented that the machine gun would be "a valuable tool in helping civilization to overcome barbarism"

During the period between 1880 and 1914, British industrial and colonial dominance began to be challenged. Industrialism had spread from Britain to Belgium, Germany and the United States, and, to a lesser extent, to France, Italy, Russia and Japan. By 1914, Germany was producing twice as much steel as Britain, and the United States was producing four times as much. . New techniques in weaponry were introduced, and a naval armaments race began among the major industrial powers. The English found that their old navy was obsolete, and they had to rebuild. Thus, the period of colonial expansion between 1880 and 1914 was filled with tensions, as the industrial powers raced to arm themselves in competition with each other, and raced to seize as much as possible of the rest of the world.

The English economist and Fabian, John Atkinson Hobson (1858-1940), offered a famous explanation of the colonial era in his book "Imperialism: A Study" (1902). According to Hobson, the basic problem that led to colonial expansion was an excessively unequal distribution of incomes in the industrialized countries. The result of this unequal distribution was that neither the rich nor the poor could buy back the total output of their society. The incomes of the poor were insufficient, and rich were too few in number. The rich had finite needs, and tended to reinvest their money. As Hobson pointed out, reinvestment in new factories only made the situation worse by increasing output.

Hobson had been sent as a reporter by the Manchester Guardian to cover the Second Boer War. His experiences had convinced him that colonial wars have an economic motive. Such wars are fought, he believed, to facilitate investment of the excess money of the rich in African or Asian plantations and mines, and to make possible the overseas sale of excess manufactured goods. Hobson believed imperialism to be immoral, since it entails suffering both among colonial peoples and among the poor of the industrial nations. The cure that he recommended was a more equal distribution of incomes in the manufacturing countries.

Outlawing war

Industrial and colonial rivalry contributed to the outbreak of the First World War, to which the Second World War can be seen as a sequel. The Second World War was terrible enough to make world leaders resolve to end the institution of war once and for all, and the United Nations was set up for this purpose. Article 2 of the UN Charter requires that "All members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state."

The Nuremberg principles, which were used in the trial of Nazi leaders after World War II, explicitly outlawed "Crimes against peace: (i) Planning, preparation, initiation or waging of war of aggression or a war in violation of international treaties, agreements or assurances; (ii) Participation in a common plan or conspiracy for the accomplishment of any of the acts mentioned under (i)."

With the founding of the United Nations at the end of the Second World War, a system of international law was set up to replace the rule of military force. Law is a mechanism for equality. Under law, the weak and the powerful are in principle equal. The basic purpose of the United Nations is to make war illegal, and if war is illegal, the powerful and weak are on equal footing, much to the chagrin of the powerful. How can one can one construct or maintain an empire if war is not allowed? It is only natural that powerful nations should be opposed to international law, since it is a curb on their power. However, despite opposition, the United Nations was quite successful in ending the original era of colonialism, perhaps because of the balance of power between East and West during the Cold War. One by one, former colonies regained their independence. But it was not to last. The original era of colonialism was soon replaced by neocolonialism and by "The American Empire".

It seems to be possible for nations, and the majority of their citizens, to commit the worst imaginable atrocities, including torture, murder and genocide, while feeling that what they are doing is both noble and good. Some understanding of how this is possible can be gained by watching the 3-part BBC documentary, "The History of Racism".

The series was broadcast by BBC Four in March 2007. and videos of the broadcasts are available on the Internet. Watching this eye-opening documentary can give us much insight into the link between racism and colonialism. We can also begin to see how both racism and colonialism are linked to US exceptionalism and neocolonialism.

Looking at the BBC documentary we can see how often in human history economic greed and colonial exploitation have been justified by racist theories. The documentary describes almost unbelievable cruelties committed against the peoples of the Americas and Africa by Europeans. For example, in the Congo, a vast region which King Leopold II of Belgium claimed as his private property, the women of villages were held as hostages while the men were forced to gather rubber in the forests. Since neither the men nor the women could produce food under these circumstances, starvation was the result.

Leopold's private army of 90,000 men were issued ammunition, and to make sure that they used it in the proper way, the army was ordered to cut off the hands of their victims and send them back as proof that the bullets had not been wasted. Human hands became a kind of currency, and hands were cut off from men, women and children when rubber quotas were not fulfilled. Sometimes more than a thousand human hands were gathered in a single day. During the rule of Leopold, roughly 10,000,000 Congolese were killed, which was approximately half the population of the region.

According to the racist theories that supported these atrocities, it was the duty of philanthropic Europeans like Leopold to bring civilization and the Christian religion to Africa. Similar theories were used to justify the genocides committed by Europeans against the native inhabitants of the Americas. Racist theories were also used to justify enormous cruelties committed by the

British colonial government in India. For example, during the great famine of 1876-1878, in which ten million people died, the Viceroy, Lord Lytton, oversaw the export from India to England of a record 6.4 million hundredweight of wheat.

Meanwhile, in Europe, almost everyone was proud of the role which they were playing in the world. All that they read in newspapers and in books or heard from the pulpits of their churches supported the idea that they were serving the non-Europeans by bringing them the benefits of civilization and Christianity. Kipling wrote: "Take up the White Man's burden, Send forth the best ye breed, Go bind your sons to exile, To serve your captives' need; To wait in heavy harness, On fluttered folk and wild, Your new-caught, sullen peoples, Half-devil and half-child." On the whole, the mood of Europe during this orgy of external cruelty and exploitation, was self-congratulatory.

Can we not see a parallel with the self-congratulatory mood countries that export violence, murder, torture and neocolonialism to the whole world, and justify it by thinking of themselves as "exceptional"?

The world urgently needs a new ethic, in which loyalty to humanity as a whole is fundamental. Racism, colonialism and exceptionalism can have no place in the future if humanity is to survive in an era of thermonuclear weapons.

The military-industrial complex

The two world wars of the 20th Century involved a complete reordering of the economies of the belligerent countries, and a dangerous modern phenomenon was created - the military-industrial complex.

In his farewell address (January 17, 1961) US President Dwight David Eisenhower warned of the dangers of the war-based economy that World War II had forced his nation to build: "...We have been compelled to create an armaments industry of vast proportions", Eisenhower said, "...Now this conjunction of an immense military establishment and a large arms industry is new in American experience. The total influence - economic, political, even spiritual - is felt in every city, every state house, every office in the federal government. ...We must not fail to comprehend its grave implications. Our toil, resources and livelihood are all involved; so is the very structure of our society. ... We must stand guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist. We must never let the weight of this combination endanger our democratic processes. We should take nothing for granted."

This farsighted speech by Eisenhower deserves to be studied by everyone who is concerned about the future of human civilization and the biosphere. As the retiring president pointed out, the military-industrial complex is a threat both to peace and to democracy. It is not unique to the United States but exists in many countries. The world today spends roughly 1.7 trillion (i.e. 1.7 million million) US dollars each year on armaments. It is obvious that very many people make their living from war, and therefore it is correct to speak of war as a social, political and economic institution. The military-industrial complex is one of the main reasons why war persists, although everyone realizes that war is the cause of much of the suffering of humanity.

A circular flow of money drives militarism

A great driving force behind militarism is the almost unimaginably enormous river of money that buys the votes of politicians and the propaganda of the mainstream media. Numbed by the propaganda, citizens allow the politicians to vote for obscenely bloated military budgets, which further enrich the corporate oligarchs, and the circular flow continues.

As long as tensions are maintained; as long as there is a threat of war, the military-industrial complex gets the money for which it lusts, and the politicians and journalists get their blood money. The safety of civilians plays no role in the money game. We are just hostages.

There is a danger that our world, with all the beauty and value that it contains, will be destroyed by this cynical game for power and money, in which civilians are militarism's hostages. Will we let this happen?

The greed of military-industrial complexes

When the United Nations was established in 1945, the purpose of the organization was to abolish the institution of war. This goal was built into many of the articles of the UN Charter. Accordingly, throughout the world, many War Departments were renamed and became Departments of Defense. But the very name is a lie. In an age of nuclear threats and counter-threats, populations are by no means protected. Ordinary citizens are just hostages in a game for power and money. It is all about greed.

Why is war continually threatened? Why is Russia threatened? Why is war with Iran threatened? Why fan the flames of conflict with China? Is it to "protect" civilians? Absolutely not! In a thermonuclear war, hundreds of millions of civilians would die horribly everywhere in the world, also in neutral countries. What is really being protected are the profits of arms manufacturers. As long as there are tensions; as long as there is a threat of war, military budgets are safe; and the profits of arms makers are safe. The people in several "democracies", for example the United States, do not rule at the moment. Greed rules.

As Institute Professor Noam Chomsky of MIT has pointed out, greed and lack of ethics are built into the structure of corporations. By law, the Chief Executive Officer of a corporation must be entirely motivated by the collective greed of the stockholders. He must maximize profits. Nothing must count except the bottom line. If the CEO abandons this single-minded chase after corporates profits for ethical reasons, or for the sake of humanity or the biosphere or the future, he (or she) must, by law, be fired and replaced.

What does Christianity say about greed?

Wikipedia states that "The seven deadly sins, also known as capital vices or cardinal sins, is a classification of vices (part of Christian ethics) that has been used since early Christian times to educate and instruct Christians concerning fallen humanity's tendency to sin. In the currently recognized version, the sins are usually given as wrath, greed, sloth, pride, lust, envy and gluttony. Each is a form of Idolatry-of-Self wherein the subjective reigns over the objective."

Saint Thomas Aquinas wrote: "Greed is a sin against God, just as all mortal sins, in as much as man condemns things eternal for the sake of temporal things".

In the New Testament, we can find many passages condemning greed, for example:

"For the love of money is the root of all evil: which while some coveted after, they have erred from the faith, and pierced themselves through with many sorrows." Timothy 6:10

"Lay not up for yourselves treasures upon earth, where moth and rust doth corrupt, and where thieves break through and steal." Mathew 6:19

In his encyclical Laudato Si', and on his recent visit to South America, Pope Francis has spoken strongly against economic activity that lacks both social and environmental ethics.

What then must we do?

Chapter 7

LESSONS FROM WORLD WAR I

There is no doubt that the founders of nationalism in Europe were idealists; but the movement that they created has already killed more than sixty million people in two world wars, and today it contributes to the threat of a catastrophic third world war.

Nationalism in Europe is an outgrowth of the Enlightenment, the French Revolution, and the Romantic Movement. According to the philosophy of the Enlightenment and the ideas of the French Revolution, no government is legitimate unless it derives its power from the will of the people. Speaking to the Convention of 1792, Danton proclaimed that "by sending us here as deputies, the French Nation has brought into being a grand committee for the general insurrection of peoples."

Since all political power was now believed to be vested in the "nation", the question of national identity suddenly became acutely important. France itself was a conglomeration of peoples - Normans, Bretons, Provencaux, Burgundians, Flemings, Germans, Basques, and Catalans - but these peoples had been united under a strong central government since the middle ages, and by the time of the French Revolution it was easy for them to think of themselves as a "nation". However, what we now call Germany did not exist. There was only a collection of small feudal principalities, in some of which the most common language was German.

The early political unity of France enabled French culture to dominate Europe during the 17th and 18th centuries. Frederick the Great of Prussia and his court spoke and wrote in French. Frederick himself regarded German as a language of ignorant peasants, and on the rare occasions when he tried to speak or write in German, the result was almost incomprehensible. The same was true in the courts of Brandenburg, Saxony, Pomerania, etc. Each of them was a small-scale Versailles. Below the French-speaking aristocracy was a German-speaking middle class and a German or Slavic-speaking peasantry.

The creators of the nationalist movement in Germany were young middle-class German-speaking students and theologians who felt frustrated and stifled by the narrow *kleinstädtisch* provincial atmosphere of the small principalities in which they lived. They also felt frustrated because their talents were completely ignored by the French-speaking aristocracy. This was the situation when the armies of Napoleon marched across Europe, easily defeating and humiliating both Prussia and Austria. The young German-speaking students asked themselves what it was that the French had that they did not have.

The answer was not hard to find. What the French had was a sense of national identity. In fact, the French Revolution had unleashed long-dormant tribal instincts in the common people of France. It was the fanatical support of the Marseillaise-singing masses that made the French armies invincible. The founders of the German nationalist movement concluded that if they were ever to have a chance of defeating France, they would have to inspire the same fanaticism in their own peoples. They would have to touch the same almost-forgotten cord of human nature that the French Revolution had touched.

The common soldiers who fought in the wars of Europe in the first part of the 18th century were not emotionally involved. They were recruited from the lowest ranks of society, and they joined the army of a king or prince for the sake of money. All this was changed by the French Revolution. In June, 1792, the French Legislative Assembly decreed that a Fatherland Alter be erected in each commune with the inscription, "The citizen is born, lives and dies for *la patrie*." The idea of a "Fatherland Alter" clearly demonstrates the quasi-religious nature of French nationalism.

The soldiers in Napoleon's army were not fighting for the sake of money, but for an ideal that they felt to be larger and more important than themselves - Republicanism and the glory of France. The masses, who for so long had been outside of the politics of a larger world, and who had been emotionally involved only in the affairs of their own village, were now fully aroused to large-scale political action. The surge of nationalist feeling in France was tribalism on an enormous scale - tribalism amplified and orchestrated by new means of mass communication.

This was the phenomenon with which the German nationalists felt they had to contend. One of the founders of the German nationalist movement was Johan Gottlieb Fichte (1762-1814), a follower of the philosopher Immanuel Kant (1724-1804). Besides rejecting objective criteria for morality, Fichte denied the value of the individual. According to him, the individual is nothing and the state is everything. Denying the value of the individual, Fichte compared the state an organism of which the individual is a part:

"In a product of nature", Fichte wrote, "no part is what it is but through its relation to the whole, and it would absolutely not be what it is apart from this relation; more, if it had no organic relation at all, it would be absolutely nothing, since without reciprocity in action between organic forces maintaining one another in equilibrium, no form would subsist... Similarly, man obtains a determinate position in the scheme of things and a fixity in nature only through his civil association... Between the isolated man and the citizen there is the same relation as between raw and organized matter... In an organized body, each part continuously maintains the whole, and in maintaining it, maintains itself also. Similarly the citizen with regard to the State."

Another post-Kantian, Adam Müller (1779-1829) wrote that "the state is the intimate association of all physical and spiritual needs of the whole nation into one great, energetic, infinitely active and living whole... the totality of human affairs... If we exclude for ever from this association even the most unimportant part of a human being, if we separate private life from public life even at one point, then we no longer perceive the State as a phenomenon of life and as an idea."

The doctrine that Adam Müller sets forth in this passage is what we now call Totalitarianism, i.e. the belief that the state ought to encompass "the totality of human affairs". This doctrine is the opposite of the Liberal belief that the individual is all-important and that the role of the state ought to be as small as possible.

Fichte maintains that "a State which constantly seeks to increase its internal strength is forced to desire the gradual abolition of all favoritisms, and the establishment of equal rights for all citizens, in order that it, the State itself, may enter upon its own true right - to apply the whole surplus power of all its citizens without exception to the furtherance of its own purposes... Internal peace, and the condition of affairs in which everyone may by diligence earn his daily bread... is only a means, a condition and framework for what love of Fatherland really wants to bring about, namely that the Eternal and the Divine may blossom in the world and never cease to become more pure, perfect and excellent."

Fichte proposed a new system of education which would abolish the individual will and teach individuals to become subservient to the will of the state. "The new education must consist essentially in this", Fichte wrote, "that it completely destroys the will in the soil that it undertakes to cultivate... If you want to influence a man at all, you must do more than merely talk to him; you must fashion him, and fashion him, and fashion him in such a way that he simply cannot will otherwise than you wish him to will."

Fichte and Herder (1744-1803) developed the idea that language is the key to national identity. They believed that the German language is superior to

French because it is an "original" language, not derived from Latin. In a poem that is obviously a protest against the French culture of Frederick's court in Prussia, Herder wrote:

> "Look at other nationalities!
> Do they wander about
> So that nowhere in the world they are strangers
> Except to themselves?
> They regard foreign countries with proud disdain.
> And you, German, alone, returning from abroad,
> Wouldst greet your mother in French?
> Oh spew it out before your door!
> Spew out the ugly slime of the Seine!
> Speak German, O you German!

Another poem, "The German Fatherland", by Ernst Moritz Arndt (1769-1860), expresses a similar sentiment:

"What is the Fatherland of the German?
Name me the great country!
Where the German tongue sounds
And sings *Lieder* in God's praise,
That's what it ought to be
Call that thine, valiant German!
That is the Fatherland of the German,
Where anger roots out foreign nonsense,
Where every Frenchman is called enemy,
Where every German is called friend,
That's what it ought to be!
It ought to be the whole of Germany!"

It must be remembered that when these poems were written, the German nation did not exist except in the minds of the nationalists. Groups of people speaking various dialects of German were scattered throughout central and eastern Europe. In many places, the German-speaking population was a minority. To bring together these scattered German-speaking groups would require, in many cases, the conquest and subjugation of Slavic majorities; but the quasi-religious fervor of the nationalists was such that aggression took on the appearance of a "holy war". Fichte believed that war between states introduces "a living and progressive principle into history". By war he did not mean a decorous limited war of the type fought in the 18th century, but "...a true and proper war - *a war of subjugation*!"

The German nationalist movement was not only quasi-religious in its tone; it also borrowed psychological techniques from religion. It aroused the emotions of the masses to large-scale political activity by the use of semi-religious political liturgy, involving myth, symbolism, and festivals. In his book "German Society" (1814), Arndt advocated the celebration of "holy festivals". For example, he thought that the celebration of the pagan festival of the summer solstice could be combined with a celebration of the victory over Napoleon at the Battle of Leipzig.

Arndt believed that special attention should be given to commemoration of the "noble dead" of Germany's wars for, as he said, "...here history enters life, and life becomes part of history". Arndt advocated a combination of Christian and pagan symbolism. The festivals should begin with prayers and a church service; but in addition, the oak leaf and the sacred flame of ancient pagan tradition were to play a part.

In 1815, many of Arndt's suggestions were followed in the celebration of the anniversary of the Battle of Leipzig. This festival clearly exhibited a mixing of secular and Christian elements to form a national cult. Men and women decorated with oak leaves made pilgrimages to the tops of mountains, where they were addressed by priests speaking in front of alters on which burned "the sacred flame of Germany's salvation". This borrowing of psychological techniques from religion was deliberate, and it was retained by the Nazi Party when the latter adopted the methods of the early German nationalists. The Nazi mass rallies retained the order and form of Protestant liturgy, including hymns, confessions of faith, and responses between the leader and the congregation.[1]

In 1832, the first mass meeting in German history took place, when 32,000 men and women gathered to celebrate the "German May". Singing songs, wearing black, red, and gold emblems, and carrying flags, they marched to Hambrach Castle, where they were addressed by their leaders.

By the 1860's the festivals celebrating the cult of nationalism had acquired a definite form. Processions through a town, involving elaborate national symbolism, were followed by unison singing by men's choirs, patriotic plays, displays by gymnasts and sharp-shooters, and sporting events. The male choirs, gymnasts and sharp-shooters were required to wear uniforms; and the others attending the festivals wore oak leaves in their caps. The cohesion of the crowd was achieved not only by uniformity of dress, but also by the space in which the crowd was contained. Arndt advocated the use of a "sacred space" for mass meetings. The idea of the "sacred space" was taken from Stonehenge, which was seen by the nationalists as a typical ancient Germanic meeting place. The Nazi art historian Hubert Schrade wrote: "The space which urges us to join the community of the *Volk* is of greater importance than the figure which is meant to represent the Fatherland."

Dramas were also used to promote a feeling of cohesion and national identity. An example of this type of propagandist drama is Kleist's play, "Hermann's Battle", (1808). The play deals with a Germanic chieftain who, in order to rally the tribes against the Romans, sends his own men, disguised as Roman soldiers, to commit atrocities in the neighboring German villages. At one point in the play, Hermann is told of a Roman soldier who risked his own life to save a German child in a burning house. Hearing this report, Hermann exclaims, "May he be cursed if he has done this! He has for a moment made my heart disloyal; he has made me for a moment betray the august cause of Germany!... I was counting, by all the gods of revenge, on fire, loot, violence, murder, and all the horrors of unbridled war! What need have I of Latins who use me well?"

[1] The Nazi sacred symbols and the concept of the swastika or "gamma cross", the eagle, the red/black/white color scheme, the ancient Nordic runes (one of which became the symbol of the SS), were all adopted from esoteric traditions going back centuries, shared by Brahmins, Scottish Masons, Rosicrutians, the Knights Templars and other esoteric societies.

At another point in the play, Hermann's wife, Thusnelda, tempts a Roman Legate into a romantic meeting in a garden. Instead of finding Thusnelda, the Legate finds himself locked in the garden with a starved and savage she-bear. Standing outside the gate, Thusnelda urges the Legate to make love to the she-bear, and, as the bear tears him to pieces, she faints with pleasure.

Richard Wagner's dramas were also part of the nationalist movement. They were designed to create "an unending dream of sacred *völkisch* revelation". No applause was permitted, since this would disturb the reverential atmosphere of the cult. A new type of choral theater was developed which "...no longer represented the fate of the individual to the audience, but that which concerns the community, the *Volk*... Thus, in contrast to the bourgeois theater, private persons are no longer represented, but only types."

We have primarily been discussing the growth of German nationalism, but very similar movements developed in other countries throughout Europe and throughout the world. Characteristic for all these movements was the growth of state power, and the development of a reverential, quasi-religious, attitude towards the state. Patriotism became "a sacred duty." According to Georg Wilhelm Fredrich Hegel, "The existence of the State is the movement of God in the world. It is the ultimate power on earth; it is its own end and object. It is an ultimate end that has absolute rights against the individual."

Nationalism in England (as in Germany) was to a large extent a defensive response against French nationalism. At the end of the 18th century, the liberal ideas of the Enlightenment were widespread in England. There was much sympathy in England with the aims of the French Revolution, and a similar revolution almost took place in England. However, when Napoleon landed an army in Ireland and threatened to invade England, there was a strong reaction towards national self-defense. The war against France gave impetus to nationalism in England, and military heros like Wellington and Nelson became objects of quasi-religious worship. British nationalism later found an outlet in colonialism.

Italy, like Germany, had been a collection of small principalities, but as a reaction to the other nationalist movements sweeping across Europe, a movement for a united Italy developed. The conflicts between the various nationalist movements of Europe produced the frightful world wars of the 20th century. Indeed, the shot that signaled the outbreak of World War I was fired by a Serbian nationalist.

War did not seem especially evil to the 18th and 19th century nationalists because technology had not yet given humanity the terrible weapons of the 20th century. In the 19th century, the fatal combination of space-age science and stone-age politics still lay in the future. However, even in 1834, the German writer Heinrich Heine was perceptive enough to see the threat:

"There will be", Heine wrote, "Kantians forthcoming who, in the world to come, will know nothing of reverence for aught, and who will ravage without mercy, and riot with sword and axe through the soil of all European life to dig out the last root of the past. There will be well-weaponed Fichtians upon the ground, who in the fanaticism of the Will are not restrained by fear or self-advantage, for they live in the Spirit."

The two world wars

In 1870, the fiercely nationalistic Prussian Chancellor, Otto von Bismark, won revenge for the humiliations which his country had suffered under Napoleon Bonaparte. In a lightning campaign, Prussia's modern army overran France and took Emperor Napoleon III prisoner. The victorious Prussians demanded from France not only the payment of a huge sum of money - five billion francs - but also the annexation of the French provinces of Alsace and Lorraine. In 1871, Kaiser Wilhelm I was proclaimed Emperor of all Germany in the Hall of Mirrors at Versailles. The dreams of the German nationalists had been realized! The small German-speaking states of central Europe were now united into a powerful nation dominated by Prussia.

Bismark had provoked a number of wars in order to achieve his aim - the unification of Germany under Prussia; but after 1871 he strove for peace, fearing that war would harm his new creation. "I am bored", Bismark remarked to his friends, "The great things are done. The German Reich is made."

In order to preserve the status quo in Europe, Bismark now made alliances not only with Austria-Hungary and Italy, but also with Russia. To make alliances with both Austria-Hungary and Russia required considerable diplomatic skill, since the two empires were enemies - rivals for influence in the Balkan Peninsula. Several small Balkan states had broken away from the decaying Turkish Empire. Both the Hapsburg Emperors and the Romanoff Czars were anxious to dominate these small states. However, nationalist emotions were even more frenzied in the Balkans than they were elsewhere in Europe. Nationalism was a cause for which 19th century Europeans were willing to kill each other, just as three centuries earlier they had been willing to kill each other over their religious differences.

Serbia was an independent state, but the fanatical Serbian nationalists were far from satisfied. Their real aim was to create an independent Pan-Serbia (or Yugoslavia) which would include all the Slavic parts of Austria-Hungary. Thus, at the turn of the century, the Balkans were a trouble spot, much as the Middle East is a trouble spot today.

Kaiser Wilhelm I was a stable monarch, but in 1888 he died and the German throne passed to his son, Frederick III, who was incurably ill with cancer of the throat. After reigning only 90 days, Frederick also died, and his 29 year old son became the new German Emperor - Kaiser Wilhelm II. Wilhelm II had been born with a withered arm, and as a boy he had been constantly told that he must become a great warrior. His adult behavior sometimes showed tendencies towards both paranoia and megalomania.

In 1890, Wilhelm dismissed Otto von Bismark ("dropping the pilot"). Bismark was now on the side of peace, and he might have guided Germany safely through the troubled waters of European politics if he had been allowed to continue; but Wilhelm wanted to play Bismark himself.

Wilhelm's first act was to break off Germany's alliance with Russia. Czar Alexander III, against his principles, then formed an alliance with republican France. Realizing that he had blundered, Wilhelm tried to patch up relations with the Czar, but it was too late. Europe was now divided into two armed camps - Germany, Austria-Hungary and Italy, opposed by Russia and France.

Wilhelm's government then began to build a huge modern navy, much to the consternation of the English. The government of England felt that it was necessary for their country to have control of the sea, since England was a densely-populated island, dependent on imports of food. It was not only with respect to naval power that England felt threatened: After being united in 1871, Germany had undergone an industrial revolution; and German industries were pouring out steel and high-quality manufactured goods that threatened England's dominance of world trade. Commercial and naval competition with the rising German Empire drove England into an informal alliance with Russia and France - the Triple Entente.

Meanwhile the situation in the Balkans became increasingly troubled, and at the end of July, 1914, the Austrian Foreign Minister, Count Brechtold, used the assassination of Archduke Francis Ferdinand and his wife as a pretext for crushing the Serbian Pan-Slavic movement. Russia mobilized against Austria in defense of the Serbs, and the Austrian government interpreted the mobilization as a declaration of war. Germany was linked to Austria by an alliance, while France was linked to Russia. In this way, both France and Russia were drawn into the conflict.

On August 2, Wilhelm demanded free passage of German troops through Belgium. The Belgians refused. They gave warning that an invasion would be resisted, and they appealed to England for support of their country's neutrality. On August 4, Britain sent an ultimatum to the Kaiser: Unless he halted the invasion of Belgium, Britain would enter the war. The invasion of Belgium rolled on. It was now too late to stop the great death-machine, and as it gained momentum, Sir Edward Grey spoke the sad and prophetic words. "The lamps are going out all over Europe; we shall not see them lit again in our lifetime."

None of the people who started the First World War had the slightest idea what it would be like. The armies of Europe were dominated by the old feudal landowning class, whose warlike traditions were rooted in the Middle Ages. The counts and barons who still ruled Europe's diplomatic and military establishments knew how to drink champaign, dance elegantly, ride horses, and seduce women. They pranced off to war in high spirits, the gold on their colorful uniforms glittering in the sunshine, full of expectations of romantic cavalry charges, kisses stolen from pretty girls in captured villages, decorations, glory and promotion, like characters in "The Chocolate Soldier" or "Die Fledermaus". The romantic dreams of glory of every small boy who ever played with toy soldiers were about to become a thrilling reality!

But the war, when it came, was not like that. Technology had taken over. The railroads, the telegraph, high explosives and the machine gun had changed everything. The opposing armies, called up by means of the telegraph and massed by means of the railroads, were the largest ever assembled up to that time in the history of the world. In France alone, between August 2 and August 18, 1914, the railway system transported 3,781,000 people under military orders. Across Europe, the railways hurled more than six million highly armed men into collision with each other. Nothing on that scale had ever happened before, and no one had any idea of what it would be like.

At first the Schlieffen Plan seemed to be working perfectly. When Kaiser Wilhelm had sent his troops into battle, he had told them: "You will be home before the leaves are off the trees", and at first it seemed that his prediction would be fulfilled. However, the machine gun had changed the character of war. Attacking infantry could be cut down in heaps by defending machine gunners. The war came to a stalemate, since defense had an advantage over attack.

On the western front, the opposing armies dug lines of trenches stretching from the Atlantic to the Swiss border. The two lines of trenches were separated by a tangled mass of barbed wire. Periodically the generals on one side or the other would order their armies to break through the opposing line. They would bring forward several thousand artillery pieces, fire a million or so high explosive shells to cut the barbed wire and to kill as many as possible of the defenders, and then order their men to attack. The soldiers had to climb out of the trenches and struggle forward into the smoke. There was nothing else for them to do. If they disobeyed orders, they would be court-marshalled and shot as deserters. They were driven forward and slaughtered in futile attacks, none of which gained anything. Their leaders had failed them. Civilization had failed them. There was nothing for them to do but to die, to be driven forward into the poison gas and barbed wire and to be scythed down by machine gun fire, for nothing, for the ambition, vanity and stupidity of their rulers.

At the battle of Verdun, 700,000 young men were butchered in this way, and at the battle of Somme, 1,100,000 young lives were wasted. On the German side, the soldiers sang “Lili Marlein” - “She waits for a boy who’s far away...” and on the other side, British and American soldiers sang:

> “There’s a long long trail a-winding
> into the land of my dreams
> where the nightingale is singing
> and the pale moon beams.
> There’s a long long night of waiting
> until my dreams all come true,
> ’til the day that I’ll be going
> down that long long trail with you.”

For millions of Europe’s young men, the long, long trail lead only to death in the mud and smoke; and for millions of mothers and sweethearts waiting at home, dreams of the future were shattered by a telegram announcing the death of the boy for whom they were waiting.

When the war ended four years later, ten million young men had been killed and twenty million wounded, of whom six million were crippled for life. The war had cost 350 trillion 1919 dollars. This was a calculable cost; but the cost in human suffering and brutalization of values was incalculable. It hardly mattered whose fault the catastrophe had been. Perhaps the Austrian government had been more to blame than any other. But blame for the war certainly did not rest with the Austrian people nor with the young Austrians who had been forced to fight. However, the tragedy of the First World War was that it created long-lasting hatred between the nations involved; and in this way it lead, only twenty years later, to an even more catastrophic global war.

The First World War brought about the downfall of four emperors: the Russian Czar, the Turkish Sultan, the Austro-Hungarian Emperor and the German Kaiser. The decaying and unjust Czarist government had for several years been threatened by revolution; and the horrors of the war into which the Czar had led his people were enough to turn them decisively against his government. During 1915 alone, Russia lost more than two million men, either killed or captured. Finally the Russian soldiers refused to be driven into battle and began to shoot their officers. In February, 1917, the Czar abdicated; and on December 5, 1917, the new communist government of Russia signed an armistice with Germany.

The German Chief of Staff, General Ludendorff, then shifted all his troops to the west in an all-out offensive. In March, 1918, he threw his entire army into a gigantic offensive which he called “the Emperor’s Battle”. The German army drove forward, and by June they were again on the Marne, only 50 miles from Paris. However, the Allies counterattacked, strengthened by the first American troops, and using, for the first time, large numbers of tanks. The Germans fell back, and by September they had lost more than a million men in six months. Morale in the retreating German army was falling rapidly, and fresh American troops were landing in France at the rate of 250,000 per month. Ludendorff realized that the German cause was hopeless and that if peace were not made quickly, a communist revolution would take place in Germany just as it had in Russia.

The old feudal Prussian military caste, having led Germany into disaster, now unloaded responsibility onto the liberals. Ludendorff advised the Kaiser to abdicate, and a liberal leader, Prince Max of Baden, was found to head the new government. On November 9, 1918, Germany was proclaimed a republic. Two days later, an armistice was signed and the fighting stopped.

During the last years of the war the world, weary of the politics of power and nationalist greed, had looked with hope towards the idealism of the American President, Woodrow Wilson. He had proposed a “peace without victory” based on his famous Fourteen Points”. Wilson himself considered that the most important of his Fourteen Points was the last one, which specified that “A general association of nations must be formed... for the purpose of affording mutual guaranties of political independence and territorial integrity of great and small states alike.”

When Wilson arrived in Europe to attend the peace conference in Paris, he was wildly cheered by crowds of ordinary people, who saw in his idealism new hope for the world. Unfortunately, the hatred produced by four years of horrible warfare was now too great to be overcome. At the peace conference, the aged nationalist Georges Clemenceau was unswerving in his deep hatred of Germany. France had suffered greatly during the war. Half of all French males who had been between the ages of 20 and 32 in 1914 had been killed; much of the French countryside had been devastated; and the retreating German armies had destroyed the French coal mines. Clemenceau was determined to extract both revenge and financial compensation from the Germans.

In the end, the peace treaty was a compromise. Wilson was given his dream, the League of Nations; and Clemenceau was given the extremely harsh terms which he insisted should be imposed on Germany. By signing the treaty, Germany would be forced to acknowledge sole responsibility for having caused the war; it would be forced to hand over the Kaiser and other leaders to be tried as war criminals; to pay for all civilian damage during the war; to agree to internationalization of all German rivers and the Kiel Canal; to give France, Belgium and Italy 25 million tons of coal annually as part of the reparations payments; to surrender the coal mines in Alsace-Lorraine to France; to give up all foreign colonies; to lose all property owned by Germans abroad; and to agree to Allied occupation of the Rhineland for fifteen years.

The loss of coal, in particular, was a death-blow aimed at German industry. Reading the terms of the treaty, the German Chancellor cried: “May the hand wither that signs such a peace!” The German Foreign Minister, Count Ulrich von Brockendorff-Rantzau, refused to sign, and the German government made public the terms of the treaty which it had been offered.

French newspapers picked up the information, and at 4 a.m. one morning, a messenger knocked at the door of the Paris hotel room where Herbert Hoover (the American war relief administrator) was staying, and handed him a copy of the terms. Hoover was so upset that he could sleep no more that night. He dressed and went out into the almost deserted Paris streets, pacing up and down, trying to calm himself. “It seemed to me”, Hoover wrote later, “that the economic consequences alone would pull down all Europe and thus injure the United States.” By chance, Hoover met the British economist, John Maynard Keynes, who was walking with General Jan Smuts in the pre-dawn Paris streets. Both of them had received transcripts of the terms offered to Germany, and both were similarly upset. “We agreed that it was terrible”, Hoover wrote later, “and we agreed that we would do what we could... to make the dangers clear.”

In the end, continuation of the blockade forced the Germans to sign the treaty; but they did so with deeply-felt bitterness. Describing the signing of the Versailles treaty on June 28, 1919, a member of the American delegation wrote: “It was not unlike when in olden times the conqueror dragged the conquered at his chariot wheel.”

While he participated in the peace negotiations, Wilson had been absent from the United States for six months. During that time, Wilson’s Democratic Party had been without its leader, and his Republican opponents made the most of the opportunity. Republican majorities had been returned in both the House of Representatives and the Senate. When Wilson placed the peace treaty before the Senate, the Senate refused to ratify it. Wilson desperately wanted America to join the League of Nations, and he took his case to the American people. He traveled 8,000 miles and delivered 36 major speeches, together with scores of informal talks urging support for the League. Suddenly, in the middle of this campaign, he was struck with a cerebral thrombosis from which he never recovered.

Without Wilson’s leadership, the campaign collapsed. The American Senate for a second time rejected the peace treaty, and with it the League of Nations. Without American participation, the League was greatly handicapped. It had many successes, especially in cultural and humanitarian projects and

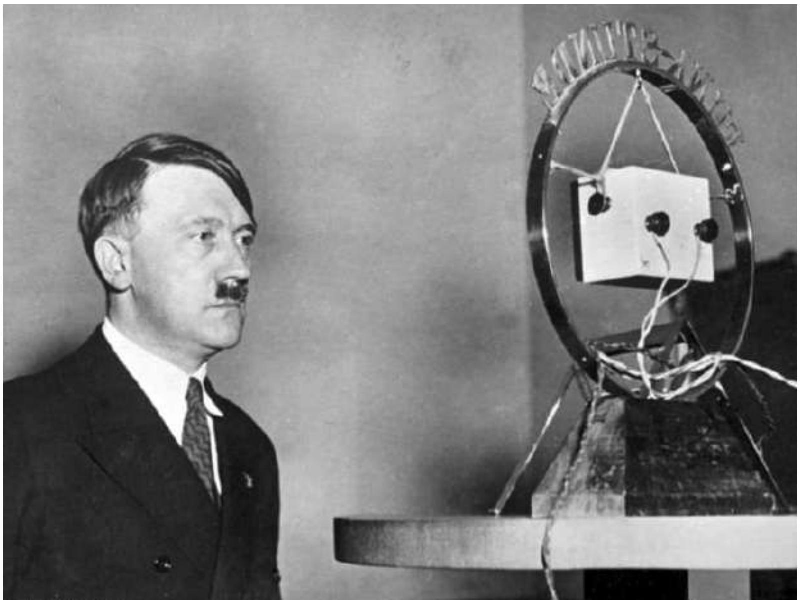

Figure 7.1: *Adolf Hitler speaking on the radio in 1933. Bundesarchiv, Bild 183-1987-0703-506 / CC-BY-SA 3.0, Wikimedia Commons*

in settling disputes between small nations; but it soon became clear that the League of Nations was not able to settle disputes between major powers.

Postwar Germany was in a state of chaos - its economy in ruins. The nation was now a republic, with its capital in Weimar, but this first experiment in German democracy was not running smoothly. Many parts of the country, especially Bavaria, were swarming with secret societies led by former officers of the German army. They blamed the republican government for the economic chaos and for signing a disgraceful peace treaty. The "war guilt" clause of the treaty especially offended the German sense of honor.

In 1920 a group of nationalist and monarchist army officers led by General Ludendorff staged an army revolt or "Putsch". They forcibly replaced the elected officials of the Weimar Republic by a puppet head of state named Dr. Kapp. However, the republic was saved by the workers of Berlin, who turned off the public utilities.

After the failure of the "Kapp Putsch", Ludendorff went to Bavaria, where he met Adolf Hitler, a member of a small secret society called the National Socialist German Workers Party. (The name was abbreviated as "Nazi" after the German pronunciation of the first two syllables of "National"). Together, Ludendorff and Hitler began to plot another "Putsch".

In 1921, the Reparations Commission fixed the amount that Germany would have to pay at 135,000,000,000 gold marks. Various western economists realized that this amount was far more than Germany would be able to pay; and in fact, French efforts to collect it proved futile. Therefore France sent army units to occupy industrial areas of the Ruhr in order to extract payment in kind. The German workers responded by sitting down at their jobs. Their salaries were paid by the Weimar government, which printed more and more paper money. The printing presses ran day and night, flooding Germany with worthless currency. By 1923, inflation had reached such ruinous proportions that baskets full of money were required to buy a loaf of bread. At one point, four trillion paper marks were equal to one dollar. This catastrophic inflation reduced the German middle class to poverty and destroyed its faith in the orderly working of society.

The Nazi Party had only seven members when Adolf Hitler joined it in 1919. By 1923, because of the desperation caused by economic chaos, it had grown to 70,000 members. On November 8, 1923, there was a meeting of nationalists and monarchists at the Bürgerbräw beer hall in Munich. The Bavarian State Commissioner, Dr. Gustav von Kahr, gave a speech denouncing the Weimar Republic. He added, however, that the time was not yet ripe for armed revolt.

In the middle of Kahr's speech, Adolf Hitler leaped to the podium. Firing two revolver bullets into the ceiling Hitler screamed that the revolution was on - it would begin immediately! He ordered his armed troopers to bar the exits, and he went from one Bavarian leader to the other, weeping with excitement, a beer stein in one hand and a revolver in the other, pleading with them to support the revolution. At this point, the figure of General Ludendorff suddenly appeared. In full uniform, and wearing all his medals, he added his pleading to that of Hitler. The Bavarian leaders appeared to yield to Hitler and Ludendorff; and that night the Nazis went into action. Wild disorder reigned in Munich. Republican newspapers and trade union offices were smashed, Jewish homes were raided, and an attempt was made to seize the railway station and the post office. However, units of policemen and soldiers were forming to resist the Nazis. Hitler realized that the Bavarian government officials under Kahr had only pretended to go along with the revolution in order to escape from the armed troopers in the beer hall.

At dawn, Hitler grouped his followers together for a parade to show their strength and to intimidate opposition. With swastika flags flying, the Nazis marched to the main square of Munich. There they met troops of Bavarian government soldiers and policemen massed in force. A volley of shots rang out, and 18 Nazis fell dead. Many other Nazis were wounded, and the remainder scattered. Hitler broke his shoulder diving for the pavement. Only General Ludendorff remained standing where he was. The half-demented old soldier, who had exercised almost dictatorial power over Germany during the last years of the war, marched straight for the Bavarian government troops.

They stepped aside and let him pass.

Adolf Hitler was arrested and sentenced to five years in prison. After serving less than a year of his sentence, he was released. He had used the time in prison to write a book, *Mein Kampf*.

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The soldiers had to climb out of the trenches and struggle forward into the smoke. There was nothing else for them to do. If they disobeyed orders, they would be court-marshaled and shot as deserters. They were driven forward and

Figure 7.2: *Trenches at the Battle of Verdun in 1916. Source: European Union Center at the University of Illinois.*

slaughtered in futile attacks, none of which gained anything. Their leaders had failed them. Civilization had failed them. There was nothing for them to do but to die, to be driven forward into the poison gas and barbed wire and to be scythed down by machine gun fire, for nothing, for the ambition, vanity and stupidity of their rulers.

At the battle of Verdun, 700,000 young men were butchered in this way, and at the battle of Somme, 1,100,000 young lives were wasted. For millions of Europe's young men, the trail lead only to death in the mud and smoke; and for millions of mothers and sweethearts waiting at home, dreams of the future were shattered by a telegram announcing the death of the boy for whom they were waiting.

When the war ended four years later, ten million young men had been killed and twenty million wounded, of whom six million were crippled for life. The war had cost 350 billion 1919 dollars. This was a calculable cost; but the cost in human suffering and brutalization of values was incalculable. It hardly mattered whose fault the catastrophe had been. Perhaps the Austrian government had been more to blame than any other. But blame for the war certainly did not rest with the Austrian people nor with the young Austrians who had been forced to fight. However, the tragedy of the First World War was that it created long-lasting hatred between the nations involved, and in this way it lead, only twenty years later, to an even more catastrophic global war.

In the Second World War, the number of soldiers killed was roughly the same as in World War I, but the numbers of civilian deaths was much larger. In the USSR alone, about 20 million people are thought to have been killed, directly or indirectly, by World War II, and of these only 7.5 million were battle deaths. Many of the USSR's civilian deaths were caused by starvation, disease or exposure. Civilian populations also suffered greatly in the devastating bombings of cities such as London, Coventry, Rotterdam, Warsaw, Dresden, Cologne, Berlin, Tokyo, Hiroshima and Nagasaki. In World War II, the total number of deaths, civilian and military, is estimated to have been between 62 and 78 million.

Do Benjamin Netanyahu and Ehud Barak, who are contemplating starting what might develop into World War III, have any imaginative concept of what it would be like? Netanyahu has told the Israeli people that only 500 of their citizens would be killed, and that the conflict would be over in a month. One is reminded of the Austrian leaders in 1914, who started a what they thought would be a small action to punish the Serbian nationalists for their Pan-Slavic ambitions. When the result was a world-destroying war, they said "That is not what we intended." Of course it is not what they intended, but nobody can control the escalation of conflicts. The astonishing unrealism of the Netanyahu-Barak statements also reminds one of Kaiser Wilhelm's monumentally unrealistic words to his departing troops: "You will be home before the leaves are off the trees."

The planned attack on Iran would not only violate international law, but would also violate common sense and the wishes of the people of Israel. The probable result would be a massive Iranian missile attack on Tel Aviv, and Iran would probably also close the Straits of Hormuz. If the United States responded by bombing Iranian targets, Iran would probably use missiles to sink one or more of the US ships in the Persian Gulf. One can easily imagine other steps in the escalation of the conflict: a revolution in Pakistan; the entry of nuclear-armed Pakistan into the war on the side of Iran; a preemptive nuclear strike by Israel against Pakistan's nuclear weapons; and Chinese-Russian support of Iran. In the tense atmosphere of such a war, the danger of a major nuclear exchange, due to accident or miscalculation, would be very great.

Today, because the technology of killing has continued to develop, the danger of a catastrophic war with hydrogen bombs hangs like a dark cloud over the future of human civilization. The total explosive power of today's weapons is equivalent to roughly half a million Hiroshima bombs. To multiply the tragedy of Hiroshima and Nagasaki by a factor of half a million changes the danger qualitatively. What is threatened today is the complete breakdown of human society.

There are 20,000 nuclear weapons in the world today, about 4,000 of them on hair-trigger alert. The phrase "hair trigger alert" means that the person in charge has only 15 minutes to decide whether the warning from the radar system was true of false, and to decide whether or not to launch a counterattack. The danger of accidental nuclear war continues to be high. Technical failures and human failures have many times brought the world close to a catastrophic nuclear war. Those who know the system of "deterrence" best describe it as "an accident waiting to happen".

No one can win a nuclear war, just as no one can win a natural catastrophe like an earthquake or a tsunami. The effects of a nuclear war would be global, and all the nations of the world would suffer - also neutral nations.

Recent studies by atmospheric scientists have shown that the smoke from burning cities produced by even a limited nuclear war would have a devastating effect on global agriculture. The studies show that the smoke would rise to the stratosphere, where it would spread globally and remain for a decade, blocking sunlight, blocking the hydrological cycle and destroying the ozone layer. Because of the devastating effect on global agriculture, darkness from even a small nuclear war could result in an estimated billion deaths from famine. This number corresponds to the fact that today, a billion people are chronically undernourished. If global agriculture were sufficiently damaged by a nuclear war, these vulnerable people might not survive. A large-scale nuclear war would be an even greater global catastrophe, completely destroying all agriculture for a period of ten years.

The tragedies of Chernobyl and Fukushima remind us that a nuclear war would make large areas of the world permanently uninhabitable because of radioactive contamination.

The First World War was a colossal mistake. Today, the world stands on the threshold of an equally enormous disaster. Must we again be lead into a world-destroying war by a few blind individuals who do not have the slightest idea of what such a war would be like?

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Chapter 8

THE SOCIAL RESPONSIBILITY OF SCIENTISTS

The special responsibility of scientists and engineers

As we start the 21st century, our scientific and technological civilization seems to be entering a period of crisis. Today, for the first time in history, science has given to humans the possibility of a life of comfort, free from hunger and cold, and free from the constant threat of infectious disease. At the same time, science has given us the power to destroy civilization through thermonuclear war, as well as the power to make our planet uninhabitable through pollution, overpopulation and climate change. The question of which of these alternatives we choose is a matter of life or death to ourselves and our children. Scientists and engineers have a special responsibility for ensuring that their work is used in a way that bebefits human civilization and the biosphere, rather than harmfully.

Genetically we are almost identical with our Neoliithic ancestors; but their world has been replaced by a world of quantum theory, relativity, supercomputers, antibiotics, genetic engineering and space telescopes - unfortunately also a world of nuclear weapons and nerve-gas. Because of the slowness of genetic evolution in comparison to the rapid and constantly-accelerating rate of cultural change, our bodies and emotions are not adapted to our new way of life. They still reflect the way of life of our hunter-gatherer ancestors.

In addition to the contrast between the slow pace of genetic evolution when compared with the rapid and constantly accelerating rate of cultural evolution, we can also notice a contrast between rapidly- and slowly-moving aspects of cultural change: Social institutions and structures seem to change slowly when compared with the lightning-like pace of scientific and technological innovation. Thus, tensions and instability characterize our information-driven contemporary society, not only because the human nature we have inheirited from our ancient ancestors is not appropriate to our present way of life, but also because science and technology change so much more rapidly than institutions, laws, and attitudes.

Space-age science and stone-age politics make an extraordinarily dangerous mixture. It seems probable that in the future, the rapidity of scientific and technological change will produce ethical dilemmas and social tensions even more acute than those we experience today. It is likely that the fate of our species (and the fate of the biosphere) will be made precarious by the astonishing speed of scientific and technological change unless this progress is matched by the achievement of far greater ethical and political maturity than we have yet attained.

Science and technology have shown themselves to be double-edged, capable of doing great good or of producing great harm, depending on the way in which we use the enormous power over nature, which science has given to us. For this reason, ethical thought is needed now more than ever before. The wisdom of the world's religions, the traditional wisdom of humankind, can help us as we try to insure that our overwhelming material progress will be beneficial.

The crisis of civilization, which we face today, has been produced by the rapidity with which science and technology have developed. Our institutions and ideas adjust too slowly to the change. The great challenge which history has given to our generation is the task of building new international political structures, which will be in harmony with modern technology. At the same time, we must develop a new global ethic, which will replace our narrow loyalties by loyalty to humanity as a whole.

Ethical considerations have traditionally been excluded from scientific discussions. This tradition perhaps has its roots in the desire of the scientific community to avoid the bitter religious controversies which divided Europe following the Reformation. Whatever the historical reason may be, it has certainly be- come customary to speak of scientific problems in a dehumanized language, as though science had nothing to do with ethics or politics.

The great power of science is derived from an enormous concentration of attention and resources on the understanding of a tiny fragment of nature; but this concentration is at the same time a distortion of values. To be effective, a scientist must believe, at least temporarily, that the problem on which he or she is working is more important than anything else in the world, which is of course untrue. Thus a scientist, while seeing a fragment of reality better than anyone else, becomes blind to the larger whole. For example, when one looks

Figure 8.1: *Enormous concentration of attention on a small fragment of reality blinds the researcher to the larger whole. Looking through a microscope, he sees what is on the slide in great detail, but he sees nothing else.*

into a microscope, one sees the tiny scene on the slide in tremendous detail, but that is all one sees. The remainder of the universe is blotted out by this concentration of attention.

The system of rewards and punishments in the training of scientists produces researchers who are highly competent when it comes to finding solutions to technical problems, but whose training has by no means encouraged them to think about the ethical or political consequences of their work. Scientists may, in fact, be tempted to escape from the intractable moral and political difficulties of the world by immersing themselves in their work. Enrico Fermi, (whose research as much as that of any other person made nuclear weapons possible), spoke of science as "soma" - the escapist drug of Aldous Huxley's Brave New World. Fermi perhaps used his scientific preoccupations as an escape from the worrying political problems of the 30's and 40's.

The education of a scientist often produces a person with a strong feeling of loyalty to a particular research discipline, but perhaps without sufficient concern for the way in which progress in that discipline is related to the general welfare of humankind. To remedy this lack, it would be very desirable if the education of scientists could include some discussion of ethics, as well as a review of the history of modern science and its impact on society.

The explosive growth of science-driven technology during the last two centuries has changed the world completely; and our social and political institutions have adjusted much too slowly to the change. The great problem of our times is to keep society from being shaken to pieces by the headlong progress of science, the problem of harmonizing our social and political institutions with technological change. Because of the great importance of this problem, it is perhaps legitimate to ask whether anyone today can be considered to be educated without having studied the impact of science on society. Should we not include this topic in the education of both scientists and non-scientists?

Science has given us great power over the forces of nature. If wisely used, this power will contribute greatly to human happiness; if wrongly used, it will result in misery. In the words of the Spanish writer, Ortega y Gasset, "We live at a time when man, lord of all things, is not lord of himself"; or as Arthur Koestler has remarked, "We can control the movements of a spaceship orbiting about a distant planet, but we cannot control the situation in Northern Ireland."

To remedy this situation, educational reforms are needed. Science and engineering students ought to have some knowledge of the history and social impact of science. They could be given a course on the history of scientific ideas; but in connection with modern historical developments, such as the industrial revolution, the global population explosion, the development of nuclear weapons, genetic engineering, and information technology, some discussion of social impact could be introduced. One might hope to build up in science and engineering students an understanding of the way in which their work is related to the general welfare of humankind. These elements are needed in science education if rapid technological development is to be beneficial rather than disastrous.

The threats and costs of war

In the long run, because of the enormously destructive weapons, which have been produced through the misuse of science, the survival of civilization can only be insured if we are able to abolish the institution of war.

Modern warfare has become prohibitively dangerous and destructive because of the enormously powerful weapons that scientists and engineers have developed. The instituteion of war could not continue without their cooperation. Thus, scientists and engineers throughout the world have a special responsibility.

Wars are driven by the collective paranoya of voters, who are willing to allow collossal sums to be spent by ' 'Defense Departments". But are civilians really defended? Absolutely not!

We can see this most clearly if we think of nuclear war. Nations threaten each other with "Mutually Assured Destruction", which has the very appropriate acronym MAD. What does this mean? Does it mean that civilians are being protected? Not at all. Instead they are threatened with complete destruction. Civilians here play the role of hostages in the power games of their leaders. Those leaders' goal is not protection of ordinary people, but rather protection of the gargantuan profits of the military-industrial complex. As the Indian writer Arundhati Roy put it, "Once weapons were manufactured to fight wars. Now wars are manufactured to sell weapons."

If a thermonuclear war occurs, it will be the end of human civilization and much of the biosphere. This will definitely happen in the future unless the world rids itself of nuclear weapons, since, in the long run, the finite chance of accidental nuclear war happening due to a technical or human failure during a given year will gradually build up into a certainty of disaster. Scientists and engineers must not sell their knowledge and talents to this march towards the preicipice.

The direct and indirect costs of war

The costs of war, both direct and indirect, are so enormous that they are almost beyond comprehension. We face a direct threat because a thermonuclear war may destroy human civilization and much of the biosphere, and an indirect threat because the institution of war interferes seriously with the use of tax money for constructive and peaceful purposes.

Today, despite the end of the Cold War, the world spends roughly 1.7 trillion (i.e. 1.7 million million) US dollars each year on armaments. This colossal flood of money could have been used instead for education, famine relief, development of infrastructure, or on urgently needed public health measures.

The World Health Organization lacks funds to carry through an antimalarial program on as large a scale as would be desirable, but the entire program could be financed for less than our military establishments spend in a single day. Five hours of world arms spending is equivalent to the total cost of the 20-year WHO campaign that resulted in the eradication of smallpox. For every 100,000 people in the world, there are 556 soldiers, but only 85 doctors. Every soldier costs an average of $20,000 per year, while the average spent on education is only $380 per school-aged child. With a diversion of funds consumed by three weeks of military spending, the world could create a sanitary water supply for all its people, thus eliminating the cause of almost half of all human illness.

A new drug-resistant form of tuberculosis has recently become widespread in Asia and in the former Soviet Union. In order to combat this new and highly dangerous form of tuberculosis and to prevent its spread, WHO needs $500 million, an amount equivalent to 1.2 hours of world arms spending.

Today's world is one in which roughly ten million children die every year

Figure 8.2: *Children born with birth defects due to the US use of Agent Orange during the Vietnam War. Source: stopwarcoalition.org*

from starvation or from diseases related to poverty. Besides this enormous waste of young lives through malnutrition and preventable disease, there is a huge waste of opportunities through inadequate education. The rate of illiteracy in the 25 least developed countries is 80%, and the total number of illiterates in the world is estimated to be 800 million. Meanwhile every 60 seconds the world spends $6.5 million on armaments.

It is plain that if the almost unbelievable sums now wasted on the institution of war were used constructively, most of the pressing problems of humanity could be solved, but today the world spends more than 20 times as much on war as it does on development.

Medical and psychological consequences; loss of life

While in earlier epochs it may have been possible to confine the effects of war mainly to combatants, in the 20th century the victims of war were increasingly civilians, and especially children. For example, according to Quincy Wright's statistics, the First and Second World Wars cost the lives of 26 million soldiers, but the toll in civilian lives was much larger: 64 million.

Since the Second World War, despite the best efforts of the UN, there have been over 150 armed conflicts; and, if civil wars are included, there are on any given day an average of 12 wars somewhere in the world. In the conflicts in Indo-China, the proportion of civilian victims was between 80% and 90%, while in the Lebanese civil war some sources state that the proportion of civilian casualties was as high as 97%.

Civilian casualties often occur through malnutrition and through diseases that would be preventable in normal circumstances. Because of the social disruption caused by war, normal supplies of food, safe water and medicine are interrupted, so that populations become vulnerable to famine and epidemics.[1]

[1]http://www.cadmusjournal.org/article/volume-2/issue-2-part-3/lessons-world-war-i

Figure 8.3: *A little girl cries as medics attend to her injuries at al-Shifa hospital in Gaza in 2014, during the conflict. Photo: UNICEF/Eyad El Baba*

Effects of war on children

According to UNICEF figures, 90% of the casualties of recent wars have been civilians, and 50% children. The organization estimates that in recent years, violent conflicts have driven 20 million children from their homes. They have become refugees or internally displaced persons within their own countries.

During the last decade 2 million children have been killed and 6 million seriously injured or permanently disabled as the result of armed conflicts, while 1 million children have been orphaned or separated from their families. Of the ten countries with the highest rates of death of children under five years of age, seven are affected by armed conflicts. UNICEF estimates that 300,000 child soldiers are currently forced to fight in 30 armed conflicts throughout the world. Many of these have been forcibly recruited or abducted.

Even when they are not killed or wounded by conflicts, children often experience painful psychological traumas: the violent death of parents or close relatives, separation from their families, seeing family members tortured, displacement from home, disruption of ordinary life, exposure to shelling and other forms of combat, starvation and anxiety about the future.[2]

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http://www.truth-out.org/opinion/item/27201-the-leading-terrorist-state

[2]http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2080482/

Figure 8.4: *Asylum-seekers in a holding centre on Greece's Samos Island.*

Refugees

Human Rights Watch estimates that in 2001 there were 15 million refugees in the world, forced from their countries by war, civil and political conflict, or by gross violations of human rights. In addition, there were an estimated 22 million internally displaced persons, violently forced from their homes but still within the borders of their countries.

In 2001, 78% of all refugees came from ten areas: Afghanistan, Angola, Burma, Burundi, Congo-Kinshasa, Eritria, Iraq, the Palestinian territories, Somalia and Sudan. A quarter of all refugees are Palestinians, who make up the world's oldest and largest refugee population. 45% of the world's refugees have found sanctuaries in Asia, 30% in Africa, 19% in Europe and 5% in North America.

Refugees who have crossed an international border are in principle protected by Article 14 of the Universal Declaration of Human Rights, which affirms their right "to seek and to enjoy in other countries asylum from persecution". In 1950 the Office of the High Commissioner for Refugees was created to implement Article 14, and in 1951 the Convention Relating to the Status of Refugees was adopted by the UN. By 2002 this legally binding treaty had been signed by 140 nations. However the industrialized countries have recently adopted a very hostile and restrictive attitude towards refugees, subjecting them to arbitrary arrests, denial of social and economic rights, and even forcible return to countries in which they face persecution.

The status of internally displaced persons is even worse than that of refugees who have crossed international borders. In many cases the international community simply ignores their suffering, reluctant to interfere in the internal affairs of sovereign states. In fact, the United Nations Charter is self-contradictory in this respect, since on the one hand it calls for non-interference in the internal affairs of sovereign states, but on the other hand, people everywhere are guaranteed freedom from persecution by the Charter's Universal Declaration of Human Rights.[3]

Damage to infrastructure

Most insurance policies have clauses written in fine print exempting companies from payment of damage caused by war. The reason for this is simple. The damage caused by war is so enormous that insurance companies could never come near to paying for it without going bankrupt.

We mentioned above that the world spends 1.7 trillion dollars each year on preparations for war. A similarly colossal amount is needed to repair the damage to infrastructure caused by war. Sometimes this damage is unintended, but sometimes it is intentional.

During World War II, one of the main aims of air attacks by both sides was to destroy the industrial infrastructure of the opponent. This made some sense in a war expected to last several years, because the aim was to prevent the enemy from producing more munitions. However, during the Gulf War of 1990, the infrastructure of Iraq was attacked, even though the war was expected to be short. Electrical generating plants and water purification facilities were deliberately destroyed with the apparent aim of obtaining leverage over Iraq after the war.

In general, because war has such a catastrophic effect on infrastructure, it can be thought of as the opposite of development. War is the greatest generator of poverty.[4]

Ecological damage

Warfare during the 20th century has not only caused the loss of 175 million lives (primarily civilians) - it has also caused the greatest ecological catastrophes in human history. The damage takes place even in times of peace. Studies by Joni Seager, a geographer at the University of Vermont, conclude that "a military presence anywhere in the world is the single most reliable predictor of ecological damage".

[3]https://www.hrw.org/topic/refugees

[4]https://www.wsws.org/en/articles/2002/11/iraq-n04.html
http://www.globalresearch.ca/crimes-against-humanity-the-destruction-of-iraqs-electricity-infrastructure-the-social-economic-and-environmental-impacts/5355665
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Figure 8.5: *Image source: Greenpeace*

Modern warfare destroys environments to such a degree that it has been described as an "environmental holocaust." For example, herbicides use in the Vietnam War killed an estimated 6.2 billion board-feet of hardwood trees in the forests north and west of Saigon, according to the American Association for the Advancement of Science. Herbicides such as Agent Orange also made enormous areas of previously fertile land unsuitable for agriculture for many years to come. In Vietnam and elsewhere in the world, valuable agricultural land has also been lost because land mines or the remains of cluster bombs make it too dangerous for farming.

During the Gulf War of 1990, the oil spills amounted to 150 million barrels, 650 times the amount released into the environment by the notorious Exxon Valdez disaster. During the Gulf War an enormous number of shells made of depleted uranium were fired. When the dust produced by exploded shells is inhaled it often produces cancer, and it will remain in the environment of Iraq for decades.

Radioactive fallout from nuclear tests pollutes the global environment and causes many thousands of cases of cancer, as well as birth abnormalities. Most nuclear tests have been carried out on lands belonging to indigenous peoples. Agent Orange also produced cancer, birth abnormalities and other serious forms of illness both in the Vietnamese population and among the foreign soldiers fighting in Vietnam[5]

[5]http://www.dailymail.co.uk/news/article-2401378/Agent-Orange-Vietnamese-children-suffering-effects-herbicide-sprayed-US-Army-40-years-ago.html

Figure 8.6: *The 15 megaton explosion detonated by the United States at Bikini Atoll in 1954 produced lasting biological damage to humans and animals living on the distant Marshall Islands. Today, half a century later, the islanders still experience radiation sickness in the form of leukemia and birth defects. Source: www.theguardian.com*

The threat of nuclear war

As bad as conventional arms and conventional weapons may be, it is the possibility of a catastrophic nuclear war that poses the greatest threat to humanity. There are today roughly 16,000 nuclear warheads in the world. The total explosive power of the warheads that exist or that could be made on short notice is approximately equal to 500,000 Hiroshima bombs.

To multiply the tragedy of Hiroshima by a factor of half a million makes an enormous difference, not only quantitatively, but also qualitatively. Those who have studied the question believe that a nuclear catastrophe today would inflict irreversible damage on our civilization, genetic pool and environment.

Thermonuclear weapons consist of an inner core where the fission of uranium-235 or plutonium takes place. The fission reaction in the core is able to start a fusion reaction in the next layer, which contains isotopes of hydrogen. It is possible to add a casing of ordinary uranium outside the hydrogen layer, and under the extreme conditions produced by the fusion reaction, this ordinary uranium can undergo fission. In this way, a fission-fusion-fission bomb of almost limitless power can be produced.

For a victim of severe radiation exposure, the symptoms during the first week are nausea, vomiting, fever, apathy, delirium, diarrhoea, oropharyngeal lesions and leukopenia. Death occurs during the first or second week.

We can perhaps be helped to imagine what a nuclear catastrophe means in human terms by reading the words of a young university professor, who was

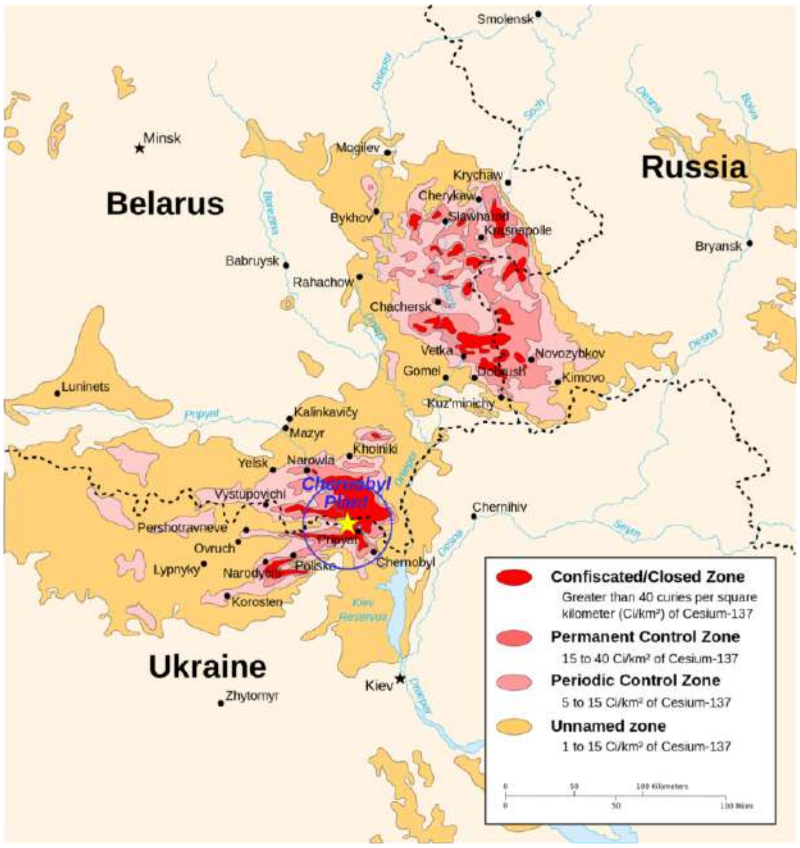

Figure 8.7: *A nuclear war would be an ecological disaster, making large portions of the world permanently uninhabitable because of long-lasting radioactivity. Chernobyl radiation map 1996 30km zone by CIA Factbook. Licensed under CC BY-SA 2.5 via Wikimedia Commons.*

2,500 meters from the hypocenter at the time of the bombing of Hiroshima: "Everything I saw made a deep impression: a park nearby covered with dead bodies... very badly injured people evacuated in my direction... Perhaps most impressive were girls, very young girls, not only with their clothes torn off, but their skin peeled off as well. ... My immediate thought was that this was like the hell I had always read about. ... I had never seen anything which resembled it before, but I thought that should there be a hell, this was it."

One argument that has been used in favor of nuclear weapons is that no sane political leader would employ them. However, the concept of deterrence ignores the possibility of war by accident or miscalculation, a danger that has been increased by nuclear proliferation and by the use of computers with very quick reaction times to control weapons systems.

Recent nuclear power plant accidents remind us that accidents frequently

Figure 8.8: *Sculpture depicting Saint George slaying the dragon. The dragon is created from fragments of Soviet SS-20 and United States Pershing nuclear missiles. UN Photo/Milton Grant*

happen through human and technical failure, even for systems which are considered to be very "safe." We must also remember the time scale of the problem. To assure the future of humanity, nuclear catastrophe must be avoided year after year and decade after decade. In the long run, the safety of civilization cannot be achieved except by the abolition of nuclear weapons, and ultimately the abolition of the institution of war.

In 1985, International Physicians for the Prevention of Nuclear War received the Nobel Peace Prize. IPPNW had been founded in 1980 by six physicians, three from the Soviet Union and three from the United States. Today, the organization has wide membership among the world's physicians. Professor Bernard Lowen of the Harvard School of Public Health, one of the founders of IPPNW, said in a recent speech:

"...No public health hazard ever faced by humankind equals the threat of nuclear war. Never before has man possessed the destructive resources to make this planet uninhabitable... Modern medicine has nothing to offer, not even a token benefit, in the event of nuclear war..."

"We are but transient passengers on this planet Earth. It does not belong to us. We are not free to doom generations yet unborn. We are not at liberty to erase humanity's past or dim its future. Social systems do not endure for eternity. Only life can lay claim to uninterrupted continuity. This continuity is sacred."

The danger of a catastrophic nuclear war casts a dark shadow over the future of our species. It also casts a very black shadow over the future of the global environment. The environmental consequences of a massive exchange of nuclear weapons have been treated in a number of studies by meteorologists and other experts from both East and West. They predict that a large-scale use of nuclear weapons would result in fire storms with very high winds and high temperatures, which would burn a large proportion of the wild land fuels in the affected nations. The resulting smoke and dust would block out sunlight for a period of many months, at first only in the northern hemisphere but later also in the southern hemisphere.

Temperatures in many places would fall far below freezing, and much of the earth's plant life would be killed. Animals and humans would then die of starvation. The nuclear winter effect was first discovered as a result of the Mariner 9 spacecraft exploration of Mars in 1971. The spacecraft arrived in the middle of an enormous dust-storm on Mars, and measured a large temperature drop at the surface of the planet, accompanied by a heating of the upper atmosphere. These measurements allowed scientists to check their theoretical models for predicting the effect of dust and other pollutants distributed in planetary atmospheres.

Using experience gained from the studies of Mars, R.P. Turco, O.B. Toon, T. Ackerman, J.B. Pollack and C. Sagan made a computer study of the climatic effects of the smoke and dust that would result from a large-scale nuclear war. This early research project is sometimes called the TTAPS Study, after the initials of the authors.

In April 1983, a special meeting was held in Cambridge, Massachusetts, where the results of the TTAPS Study and other independent studies of the nuclear winter effect were discussed by more than 100 experts. Their conclusions were presented at a forum in Washington, D.C., the following December, under the chairmanship of U.S. Senators Kennedy and Hatfield. The numerous independent studies of the nuclear winter effect all agreed of the following main predictions:

High-yield nuclear weapons exploded near the earth's surface would put large amounts of dust into the upper atmosphere. Nuclear weapons exploded over cities, forests, oilfields and refineries would produce fire storms of the type experienced in Dresden and Hamburg after incendiary bombings during the Second World War. The combination of high-altitude dust and lower altitude soot would prevent sunlight from reaching the earth's surface, and the degree of obscuration would be extremely high for a wide range of scenarios.

A baseline scenario used by the TTAPS study assumes a 5,000-megaton nuclear exchange, but the threshold for triggering the nuclear winter effect is believed to be much lower than that. After such an exchange, the screening effect of pollutants in the atmosphere might be so great that, in the northern and middle latitudes, the sunlight reaching the earth would be only 1% of ordinary sunlight on a clear day, and this effect would persist for many months. As a result, the upper layers in the atmosphere might rise in temperature by as much as 100 °C, while the surface temperatures would fall, perhaps by as much a 50 °C.

The temperature inversion produced in this way would lead to superstability, a condition in which the normal mixing of atmospheric layers is suppressed. The hydrological cycle (which normally takes moist air from the oceans to a higher and cooler level, where the moisture condenses as rain) would be strongly suppressed. Severe droughts would thus take place over continental land masses. The normal cleansing action of rain would be absent in the atmosphere, an effect which would prolong the nuclear winter.

In the northern hemisphere, forests would die because of lack of sunlight, extreme cold, and drought. Although the temperature drop in the southern hemisphere would be less severe, it might still be sufficient to kill a large portion of the tropical forests, which normally help to renew the earth's oxygen.

The oxygen content of the atmosphere would then fall dangerously, while the concentration of carbon dioxide and oxides of nitrogen produced by firestorms would remain high. The oxides of nitrogen would ultimately diffuse to the upper atmosphere, where they would destroy the ozone layer.

Thus, even when the sunlight returned after an absence of many months, it would be sunlight containing a large proportion of the ultraviolet frequencies which are normally absorbed by the ozone in the stratosphere, and therefore a type of light dangerous to life. Finally, after being so severely disturbed, there is no guarantee that the global climate would return to its normal equilibrium.

Even a nuclear war below the threshold of nuclear winter might have climatic effects very damaging to human life. Professor Paul Ehrlich, of Stanford University, has expressed this in the following words:

"...A smaller war, which set off fewer fires and put less dust into the atmosphere, could easily depress temperatures enough to essentially cancel grain production in the northern hemisphere. That in itself would be the greatest catastrophe ever delivered upon Homo Sapiens, just that one thing, not worrying about prompt effects. Thus even below the threshold, one cannot think of survival of a nuclear war as just being able to stand up after the bomb has gone off."[6]

[6]http://www.voanews.com/content/pope-francis-calls-for-nuclear-weapons-ban/2909357.html

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Nuclear weapons are criminal! Every war is a crime!

War was always madness, always immoral, always the cause of unspeakable suffering, economic waste and widespread destruction, and always a source of poverty, hate, barbarism and endless cycles of revenge and counter-revenge. It has always been a crime for soldiers to kill people, just as it is a crime for murderers in civil society to kill people. No flag has ever been wide enough to cover up atrocities.

But today, the development of all-destroying modern weapons has put war completely beyond the bounds of sanity and elementary humanity.

Today, war is not only insane, but also a violation of international law. Both the United Nations Charter and the Nuremberg Principles make it a crime to launch an aggressive war. According to the Nuremberg Principles, every soldier is responsible for the crimes that he or she commits, even while acting under the orders of a superior officer.

Nuclear weapons are not only insane, immoral and potentially omnicidal, but also criminal under international law. In response to questions put to it by WHO and the UN General Assembly, the International Court of Justice ruled in 1996 that "the threat and use of nuclear weapons would generally

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http://human-wrongs-watch.net/2015/07/22/israel-iran-and-the-nuclear-non-proliferation-treaty/

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be contrary to the rules of international law applicable in armed conflict, and particularly the principles and rules of humanitarian law." The only possible exception to this general rule might be "an extreme circumstance of self-defense, in which the very survival of a state would be at stake". But the Court refused to say that even in this extreme circumstance the threat or use of nuclear weapons would be legal. It left the exceptional case undecided. In addition, the Court added unanimously that "there exists an obligation to pursue in good faith and bring to a conclusion negotiations leading to nuclear disarmament in all its aspects under strict and effective international control."

Can we not rid ourselves of both nuclear weapons and the institution of war itself? We must act quickly and resolutely before everything that we love in our beautiful world is reduced to radioactive ashes.

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Some organizations working for peace and international law

- Pugwash Conferences on Science and World Affairs, https://pugwash.org/
- International Network of Engineers and Scientists for Global Responsibility (INES), http://www.ippnw.org/

- The Nuclear Age Peace Foundation, https://www.wagingpeace.org/
- The International Peace Bureau (IPB), http://www.ipb.org/
- UNESCO Campaign for a Culture of Peace, http://en.unesco.org/events/national-campaign-promotion-culture-peace-among-youth-cameroon
- Global Zero, https://www.globalzero.org/
- Abolition 2000, http://www.abolition2000.org/en/
- Nuclear Abolition Forum, http://www.abolitionforum.org/
- International Campaign to Abolish Nuclear Weapons (ICAN), http://www.icanw.org/
- Campaign for Nuclear Disarmament (CND), http://www.cnduk.org/
- World Association of World Federalists, http://www.wfuna.org/partner/world-federalist-movement-institute-for-global-policy-wfm-igp
- Stocckholm International Peace Research Institute (SIPRI), https://www.sipri.org/
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- Middle Powers Initiative, http://www.middlepowers.org/
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- Gandhi International Institute of Peace, http://www.gandhianpeace.com/
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Chapter 9

THE ILLEGALITY OF NUCLEAR WEAPONS

Nuclear warfare as genocide

Sixty-five years ago, on December 9, 1948, the United Nations General Assembly adopted a convention prohibiting genocide. It seems appropriate to discuss nuclear warefare against the background of this important standard of international law.

Cannot nuclear warfare be seen as an example of genocide? It is capable of killing entire populations, including babies, young children, adults in their prime and old people, without any regard for guilt or innocence. The retention of nuclear weapons, with the intent to use them under some circumstances, must be seen as the intent to commit genocide. Is it not morally degrading to see our leaders announce their intention to commit the "crime of crimes" in our names?

The use of nuclear weapons potentially involves not only genocide, but also omnicide, the death of all, since a large-scale thermonuclear war would destroy human civiliization and much of the biosphere.

If humanity is to survive in an era of all-destroying nuclear weapons, we must develop an advanced ethic to match our advanced technology. We must regard all humans as our brothers and sisters, More than that, we must actively feel our kinship with all living things, and accept and act upon our duty to protect both animate and inanimate nature.

Modern science has, for the first time in history, offered humankind the possibility of a life of comfort, free from hunger and cold, and free from the constant threat of death through infectious disease. At the same time,science has given humans the power to obliterate their civilization with nuclear.weapons, or to make the earth uninhabitable through overpopulation and.pollution. The

Figure 9.1: *A stamp honouring the great Hungarian biochemist, Albert Szent-Györgyi*

question of which of these paths we choose is literally a matter of life or death for ourselves and our children.

Will we use the discoveries of modern science constructively, and thus choose the path leading towards life? Or will we use science to produce more and more lethal weapons, which sooner or later, through a technical or human failure, may result in a catastrophic nuclear war? Will we thoughtlessly destroy our beautiful planet through unlimited growth of population and industry? The choice among these alternatives is ours to make. We live at a critical moment of history - a moment of crisis for civilization.

No one living today asked to be born at such a moment, But history has given our generation an enormous responsibility, and two daunting tasks: We must stabilize global population, and, more importantly, we must abolish both nuclear weapons and the institution of war.

The human brain has shown itself to be capable of solving even the most profound and complex problems. The mind that has seen into the heart of the atom must not fail when confronted with paradoxes of the human heart.

The problem of building a stable, just, and war-free world is difficult, but it is not impossible. The large regions of our present-day world within which war has been eliminated can serve as models. There are a number of large countries with heterogeneous populations within which it has been possible to achieve internal peace and social cohesion, and if this is possible within such extremely large regions, it must also be possible globally. We must replace the old world of international anarchy, chronic war and institutionalized injustice, by a new world of law.

The Nobel laureate biochemist Albert Szent-Györgyi once wrote: "...Modern science has abolished time and distance as factors separating nations. On our shrunken globe today, there is room for one group only: the family of man."

Nuclear Non-Proliferation Treaty, 1968

In the 1960s, negotiations were started between countries that possessed nuclear weapons, and others that did not possess them, to establish a treaty that would prevent the spread of these highly dangerous weapons, but which would at the same time encourage cooperation in the peaceful uses of nuclear energy. The resulting treaty has the formal title "Treaty on the Non-Proliferation of Nuclear Weapons" (abbreviated as the NPT). The Treaty also aimed at achieving general and complete disarmament. It was opened for signature in 1968, and it entered into force on the 11th of May, 1970.

190 parties have joined the NPT, and more countries have ratified it than any other arms limitation agreement, an indication of the Treaty's great importance. Four countries outside the NPT have nuclear weapons: India, Pakistan, North Korea and Israel. North Korea had originally joined the NPT, but it withdrew in 2003.

The NPT has three main parts or "pillars": 1) non-proliferation, 2) disarmament, and 3) the right to peaceful use of nuclear technology. The central bargain of the Treaty is that "the NPT non-nuclear weapon states agree never to acquire nuclear weapons and the NPT nuclear weapon states agree to share the benefits of peaceful use of nuclear technology and to pursue nuclear disarmament aimed at the ultimate elimination of their nuclear arsenals".

Articles I and II of the NPT forbid states that have nuclear weapons to help other nations to acquire them. These Articles were violated, for example, by France, which helped Israel to acquire nuclear weapons, and by China, which helped Pakistan to do the same. They are also violated by the "nuclear sharing" agreements, through which US tactical nuclear weapons will be transferred to several countries in Europe in a crisis situation. It is sometimes argued that in the event of a crisis, the NPT would no longer be valid, but there is nothing in the NPT itself that indicates that it would not hold in all situations.

The most blatantly violated provision of the NPT is Article VI. It requires the member states to pursue "negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament", and negotiations towards a "Treaty on general and complete disarmament". In other words, the states that possess nuclear weapons agreed to get rid of them. However, during the 47 years that have passed since the NPT went into force, the nuclear weapon states have shown absolutely no sign of complying with Article VI. There is a danger that the NPT will break down entirely because the majority of countries in the world are so dissatisfied with this long-continued non-compliance.

Looking at the NPT with the benefit of hindsight, we can see the third "pillar", the "right to peaceful use of nuclear technology", as a fatal flaw of the treaty. In practice, it has meant encouragement of nuclear power generation, with all the many dangers that go with it. The enrichment of uranium is linked to reactor use. Many reactors of modern design make use of low enriched uranium as a fuel. Nations operating such a reactor may claim that they need a program for uranium enrichment in order to produce fuel rods. However, by operating their ultracentrifuge a little longer, they can easily produce highly enriched (weapons-usable) uranium.

The difficulty of distinguishing between a civilian nuclear power generation program and a military nuclear program is illustrated by the case of Iran. In discussing Iran, it should be mentioned that Iran is fully in compliance with the NPT. It is very strange to see states that are long-time blatant violators of the NPT threaten Iran because of a nuclear program that fully complies with the Treaty.

I believe that civilian nuclear power generation is always a mistake because of the many dangers that it entails, and because of the problem of disposal of nuclear waste. However, a military attack on Iran would be both criminal and insane. Why criminal? Because such an attack would also violate the UN Charter and the Nuremberg Principles. Why insane? Because it would initiate a conflict that might escalate uncontrollably into World War III.

The 1996 ICJ decision

In 1996 the International Court of Justice ruled that "the threat and use of nuclear weapons would generally be contrary to international law." The key argument against nuclear weapons is their essentially genocidal nature. (Not only genocidal but potentially omnicidal!)

Judge Fleischhauer of Germany said in his separate opinion, "The nuclear weapon is, in many ways, the negation of the humanitarian considerations underlying the law applicable in armed conflict and the principle of neutrality. The nuclear weapon cannot distinguish between civilian and military targets. It causes immeasurable suffering. The radiation released by it is unable to respect the territorial integrity of neutral States."

President Bedjaoui, summarizing the majority opinion, called nuclear weapons "the ultimate evil", and said "By its nature, the nuclear weapon, this blind weapon, destabilizes humanitarian law, the law of discrimination in the use of weapons... The ultimate aim of every action in the field of nuclear arms will always be nuclear disarmament, an aim which is no longer utopian and which all have a duty to pursue more actively than ever." The World Court's 1996 advisory Opinion unquestionably also represents the opinion of the majority of the world's peoples. Although no formal plebiscite has been taken, the votes in numerous resolutions of the UN Gen- eral Assembly speak very clearly on this question.

The Marshall Islands sue nuclear weapons states

Violations of Article VI of the NPT

One can gain a small idea of the terrible ecological consequences of a nuclear war by thinking of the radioactive contamination that has made large areas near to Chernobyl and Fukushima uninhabitable, or the testing of hydrogen bombs in the Pacific, which continues to cause leukemia and birth defects in the Marshall Islands more than half a century later.

In 1954, the United States tested a hydrogen bomb at Bikini. The bomb was 1,300 times more powerful than the bombs that destroyed Hiroshima and Nagasaki. Fallout from the bomb contaminated the island of Rongelap, one of the Marshall Islands 120 kilometers from Bikini. The islanders experienced radiation illness, and many died from cancer.

Even today, half a century later, both people and animals on Rongelap and other nearby islands suffer from birth defects. The most common defects have been "jelly fish babies", born with no bones and with transparent skin. Their brains and beating hearts can be seen. The babies usually live a day or two before they stop breathing.

A girl from Rongelap describes the situation in the following words: "I cannot have children. I have had miscarriages on seven occasions... Our culture and religion teach us that reproductive abnormalities are a sign that women have been unfaithful. For this reason, many of my friends keep quiet about the strange births that they have had. In privacy they give birth, not to children as we like to think of them, but to things we could only describe as 'octopuses', 'apples', 'turtles', and other things in our experience. We do not have Marshallese words for these kinds of babies, because they were never born before the radiation came."

The Republic of the Marshall Islands is suing the nine countries with nuclear weapons at the International Court of Justice at The Hague, arguing they have violated their legal obligation to disarm.

The Guardian reports that "In the unprecedented legal action, comprising nine separate cases brought before the ICJ on Thursday, the Republic of the

Marshall Islands accuses the nuclear weapons states of a 'flagrant denial of human justice'. It argues it is justified in taking the action because of the harm it suffered as a result of the nuclear arms race."

"The Pacific chain of islands, including Bikini Atoll and Enewetak, was the site of 67 nuclear tests from 1946 to 1958, including the 'Bravo shot', a 15-megaton device equivalent to a thousand Hiroshima blasts, detonated in 1954. The Marshallese islanders say they have been suffering serious health and environmental effects ever since."

"The island republic is suing the five 'established' nuclear weapons states recognised in the 1968 nuclear non-proliferation treaty (NPT) - the US, Russia (which inherited the Soviet arsenal), China, France and the UK - as well as the three countries outside the NPT who have declared nuclear arsenals - India, Pakistan and North Korea, and the one undeclared nuclear weapons state, Israel."

On July 21, 2014, the United States filed a motion to dismiss the Nuclear Zero lawsuit that was filed by the Republic of the Marshall Islands (RMI) on April 24, 2014 in U.S. Federal Court. The U.S., in its move to dismiss the RMI lawsuit, does not argue that the U.S. is in compliance with its NPT disarmament obligations. Instead, it argues in a variety of ways that its non-compliance with these obligations is, essentially, justifiable, and not subject to the court's jurisdiction.

The Nuclear Age Peace Foundation (NAPF) is a consultant to the Marshall Islands on the legal and moral issues involved in bringing this case. David Krieger, President of NAPF, upon hearing of the motion to dismiss the case by the U.S. responded, "The U.S. government is sending a terrible message to the world - that is, that U.S. courts are an improper venue for resolving disputes with other countries on U.S. treaty obligations. The U.S. is, in effect, saying that whatever breaches it commits are all right if it says so. That is bad for the law, bad for relations among nations, bad for nuclear non-proliferation and disarmament - and not only bad, but extremely dangerous for U.S. citizens and all humanity."

David Krieger continued, "In 2009, President Obama shared his vision for the world, saying, 'So today, I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons.' This lawsuit provides the perfect opportunity for President Obama to move his vision forward. Yet, rather than seizing that opportunity, the U.S. government is seeking dismissal without a full and fair hearing on the merits of the case."

Our only hope for the future is to replace brutal rule by military power by a just system of international law.

Figure 9.2: *In 1954, the United States tested a hydrogen bomb at Bikini. The bomb was 1,300 times more powerful than the bombs that destroyed Hiroshima and Nagasaki.*

Figure 9.3: *Babies with severe birth defects are still being born on the Marshall Islands, 60 years after the Bikini test.*

Figure 9.4: *A just system of international law is our only hope for the future.*

The Arms Trade Treaty Opens New Possibilities at the UN

On April 2, 2013, a historic victory was won at the United Nations, and the world achieved its first treaty limiting international trade in arms. Work towards the ATT was begun in the Conference on Disarmament in Geneva, which requires a consensus for the adoption of any measure. Over the years, the consensus requirement has meant that no real progress in arms control measures has been made in Geneva, since a consensus among 193 nations is impossible to achieve. To get around the blockade, British U.N. Ambassador Mark Lyall Grant sent the draft treaty to Secretary-General Ban Ki-moon and asked him on behalf of Mexico, Australia and a number of others to put the ATT to a swift vote in the General Assembly, and on Tuesday, April 3, it was adopted by a massive majority. Among the people who have worked hardest for the ATT is Anna Macdonald, Head of Arms Control at Oxfam. The reason why Oxfam works so hard on this issue is that trade in small arms is a major cause of poverty and famine in the developing countries. On April 9, Anna Macdonald wrote:

"Thanks to the democratic process, international law will for the first time regulate the 70 billion dollar global arms trade. ...Had the process been launched in the consensus-bound Conference on Disarmament in Geneva currently in its 12th year of meeting without even being able to agree an agenda, chances are it would never have left the starting blocks. ...Striving for consensus is, of course, sensible. The problem is that it can lead to a lowest-common-denominator approach. The balance of power shifts to those, often the minority, who oppose an issue, because all the effort goes into trying to persuade them not to bring everything to a shuddering halt. ...Tuesday, April 2, was a good day for the U.N. It showed that things can get done. It showed that the democratic process can work. And it set an important precedent. Does it make any difference, legally, that the treaty was adopted by vote, not consensus? No. It is the same text as on the final day of negotiations, and its legal status is the same as if it had been agreed by consensus. But it should give hope to those working on other seemingly intractable issues that you can change the rules of the game and make progress."

I think that the point made by Anna Macdonald is an enormously important one. The success achieved by moving discussion of the Arms Trade Treaty from the Conference on Disarmament to the UN General Assembly points the way to progress on many other issues, especially the adoption of a Nuclear Weapons Convention. In my opinion, it is highly desirable to make a motion for the adoption of a Nuclear Weapons Convention on the floor of the General Assembly, following exactly the same procedure as was followed with the ATT.

If this is done, the NWC (a draft of which is already prepared) would certainly be adopted by a large majority. It might be objected that the nuclear weapon states would be offended by this procedure, but I believe that they deserve to be offended, since the threat or use of nuclear weapons is illegal according to the 1996 ruling of the International Court of Justice, and in fact the threat or use of force in international relations is a violation of the UN Charter. The adoption of the NWC would make clear the will of the great majority of the world's peoples, who consider the enormous threat which nuclear war poses to human civilization and the biosphere to be completely unacceptable.

It is not only the ATT that forms a precedent, but also the International Criminal Court, whose establishment was vehemently opposed by several militarily powerful states. Nevertheless, the ICC was adopted because a majority of the peoples of the world believed it to be a step forward towards a stable, peaceful and just global society.

In 1998, in Rome, representatives of 120 countries signed a statute establishing a International Criminal Court, with jurisdiction over the crime of genocide, crimes against humanity, war crimes, and the crime of aggression.

Four years were to pass before the necessary ratifications were gathered, but by Thursday, April 11, 2002, 66 nations had ratified the Rome agreement, 6 more than the 60 needed to make the court permanent. It would be impossible to overstate the importance of the International Criminal Court. At last international law acting on individuals has become a reality! The only effective and just way that international laws can act is to make individuals responsible and punishable, since (in the words of Alexander Hamilton), "To coerce states is one of the maddest projects ever devised."

Although the ICC is in place, it has the defect that since it opposed by powerful states, it functions very imperfectly. Should the Nuclear Weapons Convention be adopted by the UN General Assembly despite the opposition of the nuclear weapon states, it would have the same defect. It would function imperfectly because despite the support of the vast majority of the world's peoples, a few powerful opponents would remain.

Another precedent can be found in the Antipersonnel Land-Mine Convention, also known as the Ottawa Treaty. In 1991, six NGO's organized the International Campaign to Ban Landmines, and in 1996, the Canadian government launched the Ottawa process to ban landmines by hosting a meeting among like-minded anti-landmine states. A year later, in 1997, the Mine Ban Treaty was adopted and opened for signatures. In the same year, Jody Williams and the International Campaign to ban Landmines were jointly awarded the Nobel Peace Prize. After the 40th ratification of the Mine Ban Treaty in 1998, the treaty became binding international law on the 1st of March, 1999.

The adoption of a Nuclear Trade Treaty is a great step forward; the adoption of the ICC, although it is operation is imperfect, is also a great step forward, and likewise the Antipersonnel Land-Mine Convention is a great step forward. In my opinion, the adoption of a Nuclear Weapons Convention, even in the face of powerful opposition, would also be a great step forward. When the will of the majority of the world's peoples is clearly expressed in an international treaty, even if the treaty functions imperfectly, the question of legality is clear. Everyone can see which states are violating international law. In time, world public opinion will force the criminal states to conform with the law. In the case of a Nuclear Weapons Convention, world public opinion would have especially great force. It is generally agreed that a full-scale nuclear war would have disastrous effects, not only on belligerent nations but also on neutral countries. Mr.Javier Pérez de Cuéllar , former Secretary-General of the United Nations, emphasized this point in one of his speeches:

"I feel", he said, "that the question may justifiably be put to the leading nuclear powers: by what right do they decide the fate of humanity? From Scandinavia to Latin America, from Europe and Africa to the Far East, the destiny of every man and woman is affected by their actions. No one can expect to escape from the catastrophic consequences of a nuclear war on the fragile structure of this planet. ..."

"No ideological confrontation can be allowed to jeopardize the future of humanity. Nothing less is at stake: today's decisions affect not only the present; they also put at risk succeeding generations. Like supreme arbiters, with our disputes of the moment, we threaten to cut off the future and to extinguish the lives of innocent millions yet unborn. There can be no greater arrogance. At the same time, the lives of all those who lived before us may be rendered meaningless; for we have the power to dissolve in a conflict of hours or minutes the entire work of civilization, with all the brilliant cultural heritage of humankind."

"...In a nuclear age, decisions affecting war and peace cannot be left to military strategists or even to governments. They are indeed the responsibility of every man and woman. And it is therefore the responsibility of all of us... to break the cycle of mistrust and insecurity and to respond to humanity's yearning for peace."

The eloquent words of Javier PÃ©rez de CuÃ©llar express the situation in which we now find ourselves: Accidental nuclear war, nuclear terrorism, insanity of a person in a position of power, or unintended escalation of a conflict, could at any moment plunge our beautiful world into a catastrophic thermonuclear war which might destroy not only human civilization but also much of the biosphere. We are reminded that such a disaster could occur at any moment by the threat of an attack by Israel on Iran and by the threat of an all-destroying nuclear war started by the conflict in the Korean Peninsula.

It is clear that if the peoples of the world do not act quickly to abolish nuclear weapons, neither we nor our children nor our grandchildren have much chance of survival.

In the dangerous situation that could potentially result from an attack on Iran orNorth Korea, there is a risk that nuclear weapons would be used, either intentionally, or by accident or miscalculation. Recent research has shown that besides making large areas of the world uninhabitable through long-lasting radioactive contamination, a nuclear war would damage global agriculture to such a extent that a global famine of previously unknown proportions would result.

Thus, nuclear war is the ultimate ecological catastrophe. It could destroy human civilization and much of the biosphere. To risk such a war would be an unforgivable offense against the lives and future all the peoples of the world, US citizens included.

A Nuclear Weapons Convention has been passed by the UN General Assembly!

On July 7, 2017, a treaty banning nuclear weapons was adopted by an overwhelming majority at the United Nations General Assembly [34]. Although opposed by all of the nuclear weapon states, the treaty is a great achievement. Here are the first two articlea of the treaty: [1]

Article 1: Prohibitions

1. Each State Party undertakes never under any circumstances to:

    (a) Develop, test, produce, manufacture, otherwise acquire, possess or stockpile nuclear weapons or other nuclear explosive devices;

    (b) Transfer to any recipient whatsoever nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices directly or indirectly;

    (c) Receive the transfer of or control over nuclear weapons or other nuclear explosive devices directly or indirectly;

    (d) Use or threaten to use nuclear weapons or other nuclear explosive devices;

[1] The remaining articles can be found on the folloeing link: http://undocs.org/A/CONF.229/2017/8

(e) Assist, encourage or induce, in any way, anyone to engage in any activity prohibited to a State Party under this Treaty;

(f) Seek or receive any assistance, in any way, from anyone to engage in any activity prohibited to a State Party under this Treaty;

(g) Allow any stationing, installation or deployment of any nuclear weapons or other nuclear explosive devices in its territory or at any place under its jurisdiction or control.

Article 2: Declarations

1. Each State Party shall submit to the Secretary - General of the United Nations, not later than 30 days after this Treaty enters into force for that State Party, a declaration in which it shall:

   (a) Declare whether it owned, possessed or controlled nuclear weapons or nuclear explosive devices and eliminated its nuclear weapon programme, including the elimination or irreversible conversion of all nuclear weapons-related facilities, prior to the entry into force of this Treaty for that State Party;

   (b) Notwithstanding Article 1 (a), declare whether it owns, possesses or controls any nuclear weapons or other nuclear explosive devices;

   (c) Notwithstanding Article 1 (g), declare whether there are any nuclear weapons or other nuclear explosive devices in its territory or in any place under its jurisdiction or control that are owned, possessed or controlled by another State.

2. The Secretary-General of the United Nations shall transmit all such declarations received to the States Parties

The illegality of NATO

Violation of the UN Charter and the Nuremberg Principles

In recent years, participation in NATO has made European countries accomplices in US efforts to achieve global hegemony by means of military force, in violation of international law, and especially in violation of the UN Charter, the Nuremberg Principles.

Former UN Assistant Secretary General Hans Christof von Sponeck used the following words to express his opinion that NATO now violates the UN

Charter and international law: "In the 1949 North Atlantic Treaty, the Charter of the United Nations was declared to be NATO's legally binding framework. However, the United-Nations monopoly of the use of force, especially as specified in Article 51 of the Charter, was no longer accepted according to the 1999 NATO doctrine. NATO's territorial scope, until then limited to the Euro-Atlantic region, was expanded by its members to include the whole world"

Article 2 of the UN Charter requires that "All members shall refrain in their international relations from the threat or use of force against the territorial integrity or political independence of any state." This requirement is somewhat qualified by Article 51, which says that "Nothing in the present Charter shall impair the inherent right of individual or collective self-defense if an armed attack occurs against a Member of the United Nations, until the Security Council has taken measures necessary to maintain international peace and security."

Thus, in general, war is illegal under the UN Charter. Self-defense against an armed attack is permitted, but only for a limited time, until the Security Council has had time to act. The United Nations Charter does not permit the threat or use of force in preemptive wars, or to produce regime changes, or for so-called "democratization", or for the domination of regions that are rich in oil. NATO must not be a party to the threat or use of force for such illegal purposes.

In 1946, the United Nations General Assembly unanimously affirmed "the principles of international law recognized by the Charter of the Nuremberg Tribunal and the judgment of the Tribunal". The General Assembly also established an International Law Commission to formalize the Nuremberg Principles. The result was a list that included Principles VI and VII, which are particularly important in the context of the illegality of NATO:

1. **Principle VI**

   The crimes hereinafter set out are punishable as crimes under international law:

   (a) **Crimes against peace**

      i. Planning, preparation, initiation or waging of a war of aggression or a war in violation of international treaties, agreements or assurances;
      ii. Participation in a common plan or conspiracy for the accomplishment of any of the acts mentioned under (i).

   (b) **War crimes**

      Violations of the laws or customs of war which include, but are not limited to, murder, ill-treatment or deportation to slave-labor or for any other purpose of civilian population of or in occupied territory, murder or illtreatment of prisoners of war, of persons on the seas, killing of hostages, plunder of public or private property, wanton destruction of cities, towns, or villages, or devastation not justified by military necessity.

(c) **Crimes against humanity**

Murder, extermination, enslavement, deportation and other inhuman acts done against any civilian population, or persecutions on political, racial or religious grounds, when such acts are done or such persecutions are carried on in execution of or in connection with any crime against peace or any war crime.

Robert H. Jackson, who was the chief United States prosecutor at the Nuremberg trials, said that "To initiate a war of aggression is therefore not only an international crime, it is the supreme international crime, differing from other war crimes in that it contains within itself the accumulated evil of the whole."

Violation of the Nuclear Nonproliferation Treaty

At present, NATO's nuclear weapons policies violate both the spirit and the text of the Nuclear Nonproliferation Treaty in several respects: Today there are an estimated 200 US nuclear weapons still in Europe The air forces of the nations in which they are based are regularly trained to deliver the US weapons. This "nuclear sharing", as it is called, violates Articles I and II of the NPT, which forbid the transfer of nuclear weapons to non-nuclear-weapon states. It has been argued that the NPT would no longer be in force if a crisis arose, but there is nothing in the NPT saying that the treaty would not hold under all circumstances.

The principle of no-first-use of nuclear weapons has been an extremely important safeguard over the years, but it is violated by present NATO policy, which permits the first-use of nuclear weapons in a wide variety of circumstances.

During the period from 1945 to the present, the US interfered, militarily or covertly, in the internal affairs of a large number of nations: China, 1945-49; Italy, 1947-48; Greece, 1947-49; Philippines, 1946-53; South Korea, 1945-53; Albania, 1949-53; Germany, 1950s; Iran, 1953; Guatemala, 1953-1990s; Middle East, 1956-58; Indonesia, 1957-58; British Guiana/Guyana, 1953-64; Vietnam, 1950-73; Cambodia, 1955-73; The Congo/Zaire, 1960-65; Brazil, 1961-64; Dominican Republic, 1963-66; Cuba, 1959-present; Indonesia, 1965; Chile, 1964-73; Greece, 1964-74; East Timor, 1975-present; Nicaragua, 1978-89; Grenada, 1979-84; Libya, 1981-89; Panama, 1989; Iraq, 1990-present; Afghanistan 1979-92; El Salvador, 1980-92; Haiti, 1987-94; Yugoslavia, 1999; and Afghanistan, 2001-present, Syria, 2013-present. Egypt, 2013-present.

Must Europe really be dragged into a potentially catastrophic war with Russia?

At present the United States government is trying to force the European members of NATO to participate in aggressive operations in connection with the coup which it carried out in Ukraine. NATO has also carried out threatening exercises on Russia's western borders.

The hubris, and reckless irresponsibility of the US government in risking a catastrophic war with Russia is almost beyond belief, but the intervention in Ukraine is only one in a long series of US interventions:

During the period from 1945 to the present, the US interfered, militarily or covertly, in the internal affairs of a large number of nations: China, 1945-49; Italy, 1947-48; Greece, 1947-49; Philippines, 1946-53; South Korea, 1945-53; Albania, 1949-53; Germany, 1950s; Iran, 1953; Guatemala, 1953-1990s; Middle East, 1956-58; Indonesia, 1957-58; British Guiana/Guyana, 1953-64; Vietnam, 1950-73; Cambodia, 1955-73; The Congo/Zaire, 1960-65; Brazil, 1961-64; Dominican Republic, 1963-66; Cuba, 1959-present; Indonesia, 1965; Chile, 1964-73; Greece, 1964-74; East Timor, 1975-present; Nicaragua, 1978-89; Grenada, 1979-84; Libya, 1981-89; Panama, 1989; Iraq, 1990-present; Afghanistan 1979-92; El Salvador, 1980-92; Haiti, 1987-94; Yugoslavia, 1999; and Afghanistan, 2001-present, Syria, 2013-present. Egypt, 2013-present.

Most of these interventions were explained to the American people as being necessary to combat communism (or more recently, terrorism), but an underlying motive was undoubtedly the desire of the ruling oligarchy to put in place governments and laws that would be favorable to the economic interests of the US and its allies. Also, the military-industrial complex needs justification for the incredibly bloated military budgets that drain desperately needed resources from social and environmental projects.

Do the people of Europe really want to participate in the madness of aggression against Russia? Of course not! What about European leaders? Why don't they follow the will of the people and free Europe from bondage to the United States? Have our leaders been bribed? Or have they been blackmailed through personal secrets, discovered by the long arm of NSA spying?

Suggestions for further reading

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Chapter 10

AGAINST NUCLEAR POWER GENERATION

The Chernobyl disaster

The dangers of nuclear power generation are exemplified by the Chernobyl disaster: On the 26th of April, 1986, during the small hours of the morning, the staff of the Chernobyl nuclear reactor in Ukraine turned off several safety systems in order to perform a test. The result was a core meltdown in Reactor 4, causing a chemical explosion that blew off the reactor's 1,000-ton steel and concrete lid. 190 tons of highly radioactive uranium and graphite were hurled into the atmosphere. The resulting radioactive fallout was 200 times greater than that caused by the nuclear bombs that destroyed Hiroshima and Nagasaki. The radioactive cloud spread over Belarus, Ukraine, Russia, Finland, Sweden and Eastern Europe, exposing the populations of these regions to levels of radiation 100 times the normal background. Ultimately, the radioactive cloud reached as far as Greenland and parts of Asia.

The exact number of casualties resulting from the Chernobyl meltdown is a matter of controversy, but according to a United Nations report, as many as 9 million people have been adversely affected by the disaster. Since 1986, the rate of thyroid cancer in affected areas has increased ten-fold. An area of 155,000 square kilometers (almost half the size of Italy) in Belarus, Ukraine and Russia is still severely contaminated. Even as far away as Wales, hundreds of farms are still under restrictions because of sheep eating radioactive grass.

Public opinion turned against nuclear power generation as a result of the Chernobyl disaster. Had the disaster taken place in Western Europe or North America, its effect on public opinion would have been still greater. Nevertheless, because of the current energy crisis, and because of worries about global warming, a number of people are arguing that nuclear energy should be given a second chance. The counter-argument is that a large increase in the share of nuclear power in the total spectrum of energy production would have little effect on climate change but it would involve unacceptable dangers, not only dangers of accidents and dangers associated with radioactive waste disposal, but above all, dangers of proliferation of nuclear weapons.

Of the two bombs that destroyed Hiroshima and Nagasaki, one made use of the rare isotope of uranium, U-235, while the other used plutonium. Both of these materials can be made by a nation with a nuclear power generation program.

Reactors and nuclear weapons

Uranium has atomic number 92, i.e., a neutral uranium atom has a nucleus containing 92 positively-charged protons, around which 92 negatively-charged electrons circle. All of the isotopes of uranium have the same number of protons and electrons, and hence the same chemical properties, but they differ in the number of neutrons in their nuclei. For example, the nucleus of U-235 has 143 neutrons, while that of U-238 has 146. Notice that 92+143=235, while 92+146=238. The number written after the name of an element to specify a particular isotope is the number of neutrons plus the number of protons. This is called the "nucleon number", and the weight of an isotope is roughly proportional to it. This means that U-238 is slightly heavier than U-235. If the two isotopes are to be separated, difficult physical methods dependent on mass must be used, since their chemical properties are identical. In natural uranium, the amount of the rare isotope U-235 is only 0.7 percent.

A paper published in 1939 by Niels Bohr and John A. Wheeler indicated that it was the rare isotope of uranium, U-235, that undergoes fission. A bomb could be constructed, they pointed out, if enough highly enriched U-235 could be isolated from the more common isotope, U-238 Calculations later performed in England by Otto Frisch and Rudolf Peierls showed that the "critical mass" of highly enriched uranium needed is quite small: only a few kilograms.

The Bohr-Wheeler theory also predicted that an isotope of plutonium, Pu-239, should be just as fissionable as U-235[1]. Instead of trying to separate the rare isotope, U-235, from the common isotope, U-238, physicists could just

[1]Both U-235 and Pu-239 have odd nucleon numbers. When U-235 absorbs a neutron, it becomes U-236, while when Pu-239 absorbs a neutron it becomes Pu-240. In other words, absorption of a neutron converts both these species to nuclei with even nucleon numbers. According to the Bohr-Wheeler theory, nuclei with even nucleon numbers are especially tightly-bound. Thus absorption of a neutron converts U-235 to a highly-excited state of U-236, while Pu-239 is similarly converted to a highly excited state of Pu-240. The excitation energy distorts the nuclei to such an extent that fission becomes possible.

operate a nuclear reactor until a sufficient amount of Pu-239 accumulated, and then separate it out by ordinary chemical means.

Thus in 1942, when Enrico Fermi and his coworkers at the University of Chicago produced the world's first controlled chain reaction within a pile of cans containing ordinary (nonenriched) uranium powder, separated by blocks of very pure graphite, the chain-reacting pile had a double significance: It represented a new source of energy for mankind, but it also had a sinister meaning. It represented an easy path to nuclear weapons, since one of the by-products of the reaction was a fissionable isotope of plutonium, Pu-239. The bomb dropped on Hiroshima in 1945 used U-235, while the Nagasaki bomb used Pu-239.

By reprocessing spent nuclear fuel rods, using ordinary chemical means, a nation with a power reactor can obtain weapons-usable Pu-239. Even when such reprocessing is performed under international control, the uncertainty as to the amount of Pu-239 obtained is large enough so that the operation might superficially seem to conform to regulations while still supplying enough Pu-239 to make many bombs.

The enrichment of uranium[2] is also linked to reactor use. Many reactors of modern design make use of low enriched uranium (LEU) as a fuel. Nations operating such a reactor may claim that they need a program for uranium enrichment in order to produce LEU for fuel rods. However, by operating their ultracentrifuges a little longer, they can easily produce highly enriched uranium (HEU), i.e., uranium containing a high percentage of the rare isotope U-235, and therefore usable in weapons.

Known reserves of uranium are only sufficient for the generation of 8×10^{20} joules of electrical energy [3], i.e., about 25 TWy. It is sometimes argued that a larger amount of electricity could be obtained from the same amount of uranium through the use of fast breeder reactors, but this would involve totally unacceptable proliferation risks. In fast breeder reactors, the fuel rods consist of highly enriched uranium. Around the core, is an envelope of natural uranium. The flux of fast neutrons from the core is sufficient to convert a part of the U-238 in the envelope into Pu-239, a fissionable isotope of plutonium.

Fast breeder reactors are prohibitively dangerous from the standpoint of nuclear proliferation because both the highly enriched uranium from the fuel rods and the Pu-239 from the envelope are directly weapons-usable. It would be impossible, from the standpoint of equity, to maintain that some nations have the right to use fast breeder reactors, while others do not. If all nations

[2]i.e. production of uranium with a higher percentage of U-235 than is found in natural uranium

[3]Craig, J.R., Vaugn, D.J. and Skinner, B.J., *Resources of the Earth: Origin, Use and Environmental Impact, Third Edition*, page 210.

used fast breeder reactors, the number of nuclear weapons states would increase drastically.

It is interesting to review the way in which Israel, South Africa, Pakistan, India and North Korea[4] obtained their nuclear weapons, since in all these cases the weapons were constructed under the guise of "atoms for peace", a phrase that future generations may someday regard as being tragically self-contradictory.

Israel began producing nuclear weapons in the late 1960's (with the help of a "peaceful" nuclear reactor provided by France, and with the tacit approval of the United States) and the country is now believed to possess 100-150 of them, including neutron bombs. Israel's policy is one of visibly possessing nuclear weapons while denying their existence.

South Africa, with the help of Israel and France, also weaponized its civil nuclear program, and it tested nuclear weapons in the Indian Ocean in 1979. In 1991 however, South Africa destroyed its nuclear weapons and signed the NPT.

India produced what it described as a "peaceful nuclear explosion" in 1974. By 1989 Indian scientists were making efforts to purify the lithium-6 isotope, a key component of the much more powerful thermonuclear bombs. In 1998, India conducted underground tests of nuclear weapons, and is now believed to have roughly 60 warheads, constructed from Pu-239 produced in "peaceful" reactors.

Pakistan's efforts to obtain nuclear weapons were spurred by India's 1974 "peaceful nuclear explosion". As early as 1970, the laboratory of Dr. Abdul Qadeer Khan, (a metallurgist who was to become Pakistan's leading nuclear bomb maker) had been able to obtain from a Dutch firm the high-speed ultracentrifuges needed for uranium enrichment. With unlimited financial support and freedom from auditing requirements, Dr. Khan purchased restricted items needed for nuclear weapon construction from companies in Europe and the United States. In the process, Dr. Khan became an extremely wealthy man. With additional help from China, Pakistan was ready to test five nuclear weapons in 1998. The Indian and Pakistani nuclear bomb tests, conducted in rapid succession, presented the world with the danger that these devastating weapons would be used in the conflict over Kashmir. Indeed, Pakistan announced that if a war broke out using conventional weapons, Pakistan's nuclear weapons would be used "at an early stage".

In Pakistan, Dr. A.Q. Khan became a great national hero. He was presented as the person who had saved Pakistan from attack by India by cre-

[4]Israel, India and Pakistan have refused to sign the Nuclear Non-Proliferation Treaty, and North Korea, after signing the NPT, withdrew from it in 2003.

ating Pakistan's own nuclear weapons. In a Washington Post article[5] Pervez Hoodbhoy wrote: "Nuclear nationalism was the order of the day as governments vigorously promoted the bomb as the symbol of Pakistan's high scientific achievement and self-respect..." Similar manifestations of nuclear nationalism could also be seen in India after India's 1998 bomb tests.

Early in 2004, it was revealed that Dr. Khan had for years been selling nuclear secrets and equipment to Libya, Iran and North Korea, and that he had contacts with Al-Qaeda. However, observers considered that it was unlikely that Khan would be tried, since a trial might implicate Pakistan's army as well as two of its former prime ministers.

Recent assassination attempts directed at Pakistan's President, Pervez Musharraf, emphasize the precariousness of Pakistan's government. There a danger that it may be overthrown, and that the revolutionists would give Pakistan's nuclear weapons to a subnational organization. This type of danger is a general one associated with nuclear proliferation. As more and more countries obtain nuclear weapons, it becomes increasingly likely that one of them will undergo a revolution, during the course of which nuclear weapons will fall into the hands of criminals or terrorists.

If nuclear reactors become the standard means for electricity generation as the result of a future energy crisis, the number of nations possessing nuclear weapons might ultimately be as high as 40. If this should happen, then over a long period of time the chance that one or another of these nations would undergo a revolution during which the weapons would fall into the hands of a subnational group would gradually grow into a certainty.

There is also a possibility that poorly-guarded fissionable material could fall into the hands of subnational groups, who would then succeed in constructing their own nuclear weapons. Given a critical mass of highly-enriched uranium, a terrorist group, or an organized criminal (Mafia) group, could easily construct a crude gun-type nuclear explosive device. Pu-239 is more difficult to use since it is highly radioactive, but the physicist Frank Barnaby believes that a subnational group could nevertheless construct a crude nuclear bomb (of the Nagasaki type) from this material.

We must remember the remark of U.N. Secretary General Kofi Annan after the 9/11/2001 attacks on the World Trade Center. He said, "*This time* it was not a nuclear explosion". The meaning of his remark is clear: If the world does not take strong steps to eliminate fissionable materials and nuclear weapons, it will only be a matter of time before they will be used in terrorist attacks on major cities, or by organized criminals for the purpose of extortion. Neither terrorists nor organized criminals can be deterred by the threat of nuclear

[5] 1 February, 2004

retaliation, since they have no territory against which such retaliation could be directed. They blend invisibly into the general population. Nor can a “missile defense system” prevent criminals or terrorists from using nuclear weapons, since the weapons can be brought into a port in any one of the hundreds of thousands of containers that enter on ships each year, a number far too large to be checked exhaustively.

Finally we must remember that if the number of nations possessing nuclear weapons becomes very large, there will be a greatly increased chance that these weapons will be used in conflicts between nations, either by accident or through irresponsible political decisions.

On November 3, 2003, Mohamed ElBaradei, Director General of the International Atomic Energy Agency, made a speech to the United Nations in which he called for “limiting the processing of weapons-usable material (separated plutonium and high enriched uranium) in civilian nuclear programs - as well as the production of new material through reprocessing and enrichment - by agreeing to restrict these operations to facilities exclusively under international control.” It is almost incredible, considering the dangers of nuclear proliferation and nuclear terrorism, that such restrictions were not imposed long ago.

From the facts that we have been reviewing, we can conclude that if nuclear power generation becomes widespread during a future energy crisis, and if equally widespread proliferation of nuclear weapons is to be avoided, the powers and budget of the IAEA will have to be greatly increased. All enrichment of uranium and reprocessing of fuel rods throughout the world will have to be placed be under direct international control, as has been emphasized by Mohamed ElBaradei. Because this will need to be done with fairness, such regulations will have to hold both in countries that at present have nuclear weapons and in countries that do not. It has been proposed that there should be an international fuel rod bank, to supply new fuel rods and reprocess spent ones. In addition to this excellent proposal, one might also consider a system where all power generation reactors and all research reactors would be staffed by the IAEA.

Nuclear reactors used for “peaceful” purposes unfortunately also generate fissionable isotopes of not only of plutonium, but also of neptunium and americium. Thus all nuclear reactors must be regarded as ambiguous in function, and all must be put under strict international control. One must ask whether globally widespread use of nuclear energy is worth the danger that it entails.

Let us now examine the question of whether nuclear power generation would appreciably help to prevent global warming. The fraction of nuclear power in the present energy generation spectrum is at present approximately 1/16. Nuclear energy is used primarily for electricity generation. Thus increasing the nuclear fraction would not affect the consumption of fossil fuels used directly in industry, transportation, in commerce, and in the residential sector. Coal is still a very inexpensive fuel, and an increase in nuclear power generation would do little to prevent it from being burned. Thus besides being prohibitively dangerous, and besides being unsustainable in the long run (because of finite stocks of uranium and thorium), the large-scale use of nuclear power cannot be considered to be a solution to the problem of anthropogenic climate change.

Optimists point to the possibility of using fusion of light elements, such as hydrogen, to generate power. However, although this can be done on a very small scale (and at great expense) in laboratory experiments, the practical generation of energy by means of thermonuclear reactions remains a mirage rather than a realistic prospect on which planners can rely. The reason for this is the enormous temperature required to produce thermonuclear reactions. This temperature is comparable to that existing in the interior of the sun, and it is sufficient to melt any ordinary container. Elaborate "magnetic bottles" have been constructed to contain thermonuclear reactions, and these have been used in successful very small scale experiments. However, despite 50 years of heavily-financed research, there has been absolutely no success in producing thermonuclear energy on a large scale, or at anything remotely approaching commercially competitive prices.

Cancer threat from radioactive leaks at Hanford USA

On August 9, 1945, a nuclear bomb was dropped on the Japanese city of Nagasaki. Within a radius of one mile, destruction was total. People were vaporized so that the only shadows on concrete pavements were left to show where they had been. Many people outside the radius of total destruction were trapped in their collapsed houses, and were burned alive by the fire that followed. By the end of 1945, an estimated 80,000 men, women, young children, babies and old people had died as a result of the bombing. As the years passed more people continued to die from radiation sickness.

Plutonium for the bomb that destroyed Nagasaki had been made at an enormous nuclear reactor station located at Hanford in the state of Washington. During the Cold War, the reactors at Hanford produced enough weapons-usable plutonium for 60,000 nuclear weapons. The continued existence of plutonium and highly-enriched uranium-235 in the stockpiles of nuclear weapons states hangs like a dark cloud over the future of humanity. A full scale thermonuclear war would be the ultimate ecological catastrophe, threatening to make the world permanently uninhabitable.

Besides playing a large role in the tragedy of Nagasaki, the reactor complex at Hanford has damaged the health of many thousands of Americans. The prospects for the future are even worse. Many millions of gallons of radioactive waste are held in Hanford's aging storage tanks, the majority of which have exceeded their planned lifetimes. The following quotations are taken from a Wikipedia article on Hanford, especially the section devoted to ecological concerns:

"A huge volume of water from the Columbia River was required to dissipate the heat produced by Hanford's nuclear reactors. From 1944 to 1971, pump systems drew cooling water from the river and, after treating this water for use by the reactors, returned it to the river. Before being released back into the river, the used water was held in large tanks known as retention basins for up to six hours. Longer-lived isotopes were not affected by this retention, and several tetrabecquerels entered the river every day. These releases were kept secret by the federal government. Radiation was later measured downstream as far west as the Washington and Oregon coasts."

"The plutonium separation process also resulted in the release of radioactive isotopes into the air, which were carried by the wind throughout southeastern Washington and into parts of Idaho, Montana, Oregon and British Colombia. Downwinders were exposed to radionuclide's, particularly iodine-131... These radionuclide's filtered into the food chain via contaminated fields where dairy cows grazed; hazardous fallout was ingested by communities who consumed the radioactive food and drank the milk. Most of these airborne releases were a part of Hanford's routine operations, while a few of the larger releases occurred in isolated incidents."

"In response to an article in the Spokane Spokesman Review in September 1985, the Department of Energy announced its intent to declassify environmental records and in February, 1986 released to the public 19,000 pages of previously unavailable historical documents about Hanford's operations. The Washington State Department of Health collaborated with the citizen-led Hanford Health Information Network (HHIN) to publicize data about the health effects of Hanford's operations. HHIN reports concluded that residents who lived downwind from Hanford or who used the Columbia River downstream were exposed to elevated doses of radiation that placed them at increased risk for various cancers and other diseases."

"The most significant challenge at Hanford is stabilizing the 53 million U.S. Gallons (204,000 m^3) of high-level radioactive waste stored in 177 underground tanks. About a third of these tanks have leaked waste into the soil and groundwater. As of 2008, most of the liquid waste has been transferred to more secure double-shelled tanks; however, 2.8 million U.S. Gallons (10,600 m^3) of liquid waste, together with 27 million U.S. gallons (100,000 m^3) of salt cake and sludge, remains in the single-shelled tanks.That waste was originally scheduled to be removed by 2018. The revised deadline is 2040. Nearby aquifers contain an estimated 270 billion U.S. Gallons (1 billion m^3) of contaminated groundwater as a result of the leaks. As of 2008, 1 million U.S. Gallons (4,000 m^3) of highly radioactive waste is traveling through the groundwater toward the Columbia River."

The documents made public in 1986 revealed that radiation was intentionally and secretly released by the plant and that people living near to it acted as unknowing guinea pigs in experiments testing radiation dangers. Thousands of people who live in the vicinity of the Hanford Site have suffered an array of health problems including thyroid cancers, autoimmune diseases and reproductive disorders that they feel are the direct result of these releases and experiments.

In thinking about the dangers posed by leakage of radioactive waste, we should remember that many of the dangerous radioisotopes involved have half-lives of hundreds of thousands of years. Thus, it is not sufficient to seal them into containers that will last for a century or even a millennium. We must find containers that will last for a hundred thousand years or more, longer than any human structure has ever lasted. This logic has lead Finland to deposit its radioactive waste in a complex of underground tunnels carved out of solid rock. But looking ahead for a hundred thousand years involves other problems: If humans survive for that long, what language will they speak? Certainly not the languages of today. How can we warn them that the complex of tunnels containing radioactive waste is a death trap? The reader is urged to see a film exploring these problems, "Into Eternity", by the young Danish film-maker Michael Madsen.

We have already gone a long way towards turning our beautiful planet earth into a nuclear wasteland. In the future, let us be more careful, as guardians of a precious heritage, the natural world and the lives of all future generations.

Chapter 11

THE EVOLUTION OF COOPERATION

The explosion of human knowledge

Cultural evolution depends on the non-genetic storage, transmission, diffusion and utilization of information. The development of human speech, the invention of writing, the development of paper and printing, and finally in modern times, mass media, computers and the Internet - all these have been crucial steps in society's explosive accumulation of information and knowledge. Human cultural evolution proceeds at a constantly-accelerating speed, so great in fact that it threatens to shake society to pieces.

Every species changes gradually through genetic evolution; but with humans, cultural evolution has rushed ahead with such a speed that it has completely outstripped the slow rate of genetic change. Genetically we are quite similar to our neolithic ancestors, but their world has been replaced by a world of quantum theory, relativity, supercomputers, antibiotics, genetic engineering and space telescopes - unfortunately also a world of nuclear weapons and nerve gas.

Because of the slowness of genetic evolution in comparison to the rapid and constantly-accelerating rate of cultural change, our bodies and emotions (as Malthus put it, the "passions of mankind") are not completely adapted to our new way of life. They still reflect the way of life of our hunter-gatherer ancestors.

Within rapidly-moving cultural evolution, we can observe that technical change now moves with such astonishing rapidity that neither social institutions, nor political structures, nor education, nor public opinion can keep pace. The lightning-like pace of technical progress has made many of our ideas and institutions obsolete. For example, the absolutely-sovereign nation-state and the institution of war have both become dangerous anachronisms in an era of instantaneous communication, global interdependence and all-destroying weapons.

In many respects, human cultural evolution can be regarded as an enormous success. However, at the start of the 21st century, most thoughtful observers agree that civilization is entering a period of crisis. As all curves move exponentially upward - population, production, consumption, rates of scientific discovery, and so on - one can observe signs of increasing environmental stress, while the continued existence and spread of nuclear weapons threatens civilization with destruction. Thus while the explosive growth of knowledge has brought many benefits, the problem of achieving a stable, peaceful and sustainable world remains serious, challenging and unsolved.

Tribal emotions and nationalism

In discussing conflicts, we must be very careful to distinguish between two distinct types of aggression exhibited by both humans and animals. The first is intra-group aggression, which is often seen in rank-determining struggles, for example when two wolves fight for pack leadership, or when males fight for the privilege of mating with females. Another, completely different, type of aggression is seen when a group is threatened by outsiders. Most animals, including humans, then exhibit a communal defense response - self-sacrificing and heroic combat against whatever is perceived to be an external threat. It is this second type of aggression that makes war possible.

Arthur Koestler has described inter-group aggression in an essay entitled *The Urge to Self-Destruction* [1], where he writes: "Even a cursory glance at history should convince one that individual crimes, committed for selfish motives, play a quite insignificant role in the human tragedy compared with the numbers massacred in unselfish love of one's tribe, nation, dynasty, church or ideology... Wars are not fought for personal gain, but out of loyalty and devotion to king, country or cause..."

"We have seen on the screen the radiant love of the Führer on the faces of the Hitler Youth... They are transfixed with love, like monks in ecstasy on religious paintings. The sound of the nation's anthem, the sight of its proud flag, makes you feel part of a wonderfully loving community. The fanatic is prepared to lay down his life for the object of his worship, as the lover is prepared to die for his idol. He is, alas, also prepared to kill anybody who represents a supposed threat to the idol."

[1] in *The Place of Value in a World of Facts*, A. Tiselius and S. Nielsson editors, Wiley, New York, (1970)

Members of tribe-like groups are bound together by strong bonds of altruism and loyalty. Echos of these bonds can be seen in present-day family groups, in team sports, in the fellowship of religious congregations, and in the bonds that link soldiers to their army comrades and to their nation.

Warfare involves not only a high degree of aggression, but also an extremely high degree of altruism. Soldiers kill, but they also sacrifice their own lives. Thus patriotism and duty are as essential to war as the willingness to kill.

Tribalism involves passionate attachment to one's own group, self-sacrifice for the sake of the group, willingness both to die and to kill if necessary to defend the group from its enemies, and belief that in case of a conflict, one's own group is always in the right. Unfortunately these emotions make war possible; and today a Third World War might lead to the destruction of civilization.

The mystery of self-sacrifice in war

At first sight, the willingness of humans to die defending their social groups seems hard to explain from the standpoint of Darwinian natural selection. After the heroic death of such a human, he or she will be unable to produce more children, or to care for those already born.Therefore one might at first suppose that natural selection would work strongly to eliminate the trait of self-sacrifice from human nature. However, the theory of population genetics and group selection can explain both the willingness of humans to sacrifice themselves for their own group, and also the terrible aggression that they sometimes exhibit towards competing groups. It can explain both intra-group altruism and inter-group aggression.

Fisher, Haldane and Hamilton

The idea of group selection in evolution was proposed in the 1930's by J.B.S. Haldane and R.A. Fischer, and more recently it has been discussed by W.D. Hamilton.

If we examine altruism and aggression in humans, we notice that members of our species exhibit great altruism towards their own children. Kindness towards close relatives is also characteristic of human behavior, and the closer the biological relationship is between two humans, the greater is the altruism they tend to show towards each other. This profile of altruism is easy to explain on the basis of Darwinian natural selection since two closely related individuals share many genes and, if they cooperate, the genes will be more effectively propagated.

To explain from an evolutionary point of view the communal defense mechanism - the willingness of humans to kill and be killed in defense of their communities - we have only to imagine that our ancestors lived in small tribes and that marriage was likely to take place within a tribe rather than across tribal boundaries. Under these circumstances, each tribe would tend to consist of genetically similar individuals. The tribe itself, rather than the individual, would be the unit on which the evolutionary forces of natural selection would act.

According to the group selection model, a tribe whose members showed altruism towards each other would be more likely to survive than a tribe whose members cooperated less effectively. Since several tribes might be in competition for the same territory, successful aggression against a neighboring group could increase the chances for survival of one's own tribe. Thus, on the basis of the group selection model, one would expect humans to be kind and cooperative towards members of their own group, but at the same time to sometimes exhibit aggression towards members of other groups, especially in conflicts over territory. One would also expect intergroup conflicts to be most severe in cases where the boundaries between groups are sharpest - where marriage is forbidden across the boundaries.

Language, religion and tribal markings

In biology, a species is defined to be a group of mutually fertile organisms. Thus all humans form a single species, since mixed marriages between all known races will produce children, and subsequent generations in mixed marriages are also fertile. However, although there is never a biological barrier to marriages across ethnic and racial boundaries, there are often very severe cultural barriers.

Irenäus Eibl-Eibesfeldt, a student of Konrad Lorenz, introduced the word *pseudospeciation* to denote cases where cultural barriers between two groups of humans are so strongly marked that marriages across the boundary are difficult and infrequent. In such cases, he pointed out, the two groups function as though they were separate species, although from a biological standpoint this is nonsense. When two such groups are competing for the same land, the same water, the same resources, and the same jobs, the conflicts between them can become very bitter indeed. Each group regards the other as being "not truly human".

In his book *The Biology of War and Peace*, Eibl-Eibesfeldt discusses the "tribal markings" used by groups of humans to underline their own identity and to clearly mark the boundary between themselves and other groups. One of the illustrations in his book shows the marks left by ritual scarification on the faces of the members of certain African tribes. These scars would be hard to counterfeit, and they help to establish and strengthen tribal identity.

Seeing a photograph of the marks left by ritual scarification on the faces of African tribesmen, it is impossible not to be reminded of the dueling scars that Prussian army officers once used to distinguish their caste from outsiders.

Surveying the human scene, one can find endless examples of signs that mark the bearer as a member of a particular group - signs that can be thought of as “tribal markings”: tattoos; piercing; bones through the nose or ears; elongated necks or ears; filed teeth; Chinese binding of feet; circumcision, both male and female; unique hair styles; decorations of the tongue, nose, or naval; peculiarities of dress, kilts, tartans, school ties, veils, chadors, and headdresses; caste markings in India; use or nonuse of perfumes; codes of honor and value systems; traditions of hospitality and manners; peculiarities of diet (certain foods forbidden, others preferred); giving traditional names to children; knowledge of dances and songs; knowledge of recipes; knowledge of common stories, literature, myths, poetry or common history; festivals, ceremonies, and rituals; burial customs, treatment of the dead and ancestor worship; methods of building and decorating homes; games and sports peculiar to a culture; relationship to animals, knowledge of horses and ability to ride; nonrational systems of belief. Even a baseball hat worn backwards or the professed ability to enjoy atonal music can mark a person as a member of a special “tribe”.

By far the most important mark of ethnic identity is language, and within a particular language, dialect and accent. If the only purpose of language were communication, it would be logical for the people of a small country like Denmark to stop speaking Danish and go over to a more universally-understood international language such as English. However, language has another function in addition to communication: It is also a mark of identity. It establishes the boundary of the group.

Next after language, the most important “tribal marking” is religion. The tendency to be religious seems to be an inherent part of human nature, since all known human societies have religions.

Formation of group identity

Although humans originally lived in small, genetically homogeneous tribes, the social and political groups of the modern world are much larger, and are often multiracial and multiethnic.

There are a number of large countries that are remarkable for their diversity, for example Brazil, Argentina and the United States. Nevertheless it has been possible to establish social cohesion and group identity within each of these enormous nations. India and China too, are mosaics of diverse peoples, but nevertheless, they function as coherent societies. Thus we see that group identity is a social construction, in which artificial "tribal markings" define the boundaries of the group.

As an example of the use of tribal markings to establish social cohesion over a large group of genetically dissimilar humans, one can think of the role of baseball and football in the United States. Affection for these sports and knowledge of their intricacies is able to establish social bonds that transcend racial and religious barriers.

One gains hope for the future by observing how it has been possible to produce both internal peace and social cohesion over very large areas of the globe - areas that contain extremely diverse populations. The difference between making large, ethnically diverse countries function as coherent sociopolitical units and making the entire world function as a unit is not very great.

Since group identity is a social construction, it is not an impossible goal to think of enlarging the already-large groups of the modern world to include all of humanity.

From Thomas Huxley to Lynn Margulis and symbiosis

Charles Darwin (1809-1882) was acutely aware of close and mutually beneficial relationships between organisms. For example, in his work on the fertilization of flowers, he studied the ways in which insects and plants can become exquisitely adapted to each other's needs.

On the other hand Thomas Henry Huxley (1825-1895), although he was a strong supporter of Darwin, saw competition as the main mechanism of evolution. In his essay *Struggle for Existence and its Bearing Upon Man* Huxley wrote: "From the point of view of the moralist, the animal world is about on the same level as a gladiators' show. The creatures are fairly well treated and set to fight; hereby the strongest, the swiftest, and the cunningest live to fight another day. The spectator has no need to turn his thumbs down, as no quarter is granted."

Prince Peter Kropotkin (1842-1921) argued strongly against Huxley's point of view in his book *Mutual Aid; A Factor of Evolution.* "If we ask Nature", Kropotkin wrote, "'who are the fittest: those who are continually at war with each other, or those who support one another?', we at once see that those animals that acquire habits of mutual aid are undoubtedly the fittest. They have more chances to survive, and they attain, in their respective classes, the highest development of intelligence and bodily organization."

Today, the insights of modern biology show that although competition plays an important role, most of the great upward steps in evolution have involved cooperation. The biologist Lynn Margulis (1938-2011) has been one of the pioneers of the modern viewpoint which recognizes symbiosis as a central mechanism in evolution.

One-celled organisms seen as examples of cooperation

The first small bacterial cells (prokaryotic cells) can be thought of as cooperative communities in which autocatalytic molecules thrived better together than they had previously done separately.

The next great upward step in evolution, the development of large and complex (eukaryotic) cells, also involved cooperation: Many of their components, for example mitochondria (small granular structures that are needed for respiration) and chloroplasts (the photosynthetic units of higher plants) are believed to have begun their existence as free-living prokaryotic cells. They now have become components of complex cells, cooperating biochemically with the other subcellular structures. Both mitochondria and chloroplasts possess their own DNA, which shows that they were once free-living bacteria-like organisms, but they have survived better in a cooperative relationship.

Cooperation between cells; multicellular organisms

Multicellular organisms evolved from cooperative communities of eukaryotic cells. Some insights into how this happened can be gained from examples which are just on the borderline between the multicellular organisms and single-celled ones. The cooperative behavior of a genus of unicellular eukaryotes called slime molds is particularly interesting because it gives us a glimpse of how multicellular organisms may have originated. The name of the slime molds is misleading, since they are not fungi, but are similar to amoebae.

Under ordinary circumstances, the individual cells wander about independently searching for food, which they draw into their interiors and digest. However, when food is scarce, they send out a chemical signal of distress. (Researchers have analyzed the molecule which expresses slime mold unhappiness, and they have found it to be cyclic adenosine monophosphate.) At this signal, the cells congregate and the mass of cells begins to crawl, leaving a slimy trail. At it crawls, the community of cells gradually develops into a tall stalk, surmounted by a sphere - the "fruiting body". Inside the sphere, spores are produced by a sexual process. If a small animal, for example a mouse, passes by, the spores may adhere to its coat; and in this way they may be transported to another part of the forest where food is more plentiful.

Slime molds represent a sort of missing link between unicellular and multicellular or organisms. Normally the cells behave as individualists, wandering about independently, but when challenged by a shortage of food, the slime mold cells join together into an entity which closely resembles a multicellular organism.

The cells even seem to exhibit altruism, since those forming the stalk have little chance of survival, and yet they are willing to perform their duty, holding up the sphere at the top so that the spores will survive and carry the genes of the community into the future.

Multicellular organisms often live in a symbiotic relationship with other species. For example, in both animals and humans, bacteria are essential for the digestion of food. Fungi on the roots of plants aid their absorption of water and nutrients. Communities of bacteria and other organisms living in the soil are essential for the recycling of nutrients. Insects are essential to many plants for pollination.

Cooperation in groups of animals and human groups

The social behavior of groups of animals, flocks of birds and communities of social insects involves cooperation as well as rudimentary forms of language. Various forms of language, including chemical signals, postures and vocal signals, are important tools for orchestrating cooperative behavior.

The social insects, ants, bees, wasps and termites, exhibit nearly perfect altruism towards members of their own group. This extreme form of altruism towards near relations (kin altruism) is closely connected with the peculiar method of reproduction of the social insects. The workers are sterile or nearly sterile, while the queen is the only reproductive female. The result of this special method of reproduction is that very nearly perfect altruism is possible within a hive or nest, since genetic changes favoring antisocial behavior would be detrimental to the hive or nest as a whole. The hive or nest can, in some sense, be regarded as a superorganism, with the individuals cooperating totally in much the same way that cells cooperate within a multicellular organism. The social insects exhibit aggression towards members of their own species from other hives or nests, and can be said to engage in wars. Interestingly a similar method of reproduction, associated with extreme intra-group altruism has evolved among mammals, but is represented by only two species: the naked mole rat and Damaraland mole rat.

The highly developed language of humans made possible an entirely new form of evolution. In cultural evolution (as opposed to genetic evolution), information is passed between generations not in the form of a genetic code, but in the form of linguistic symbols. With the invention of writing, and later the invention of printing, the speed of human cultural evolution greatly increased. Cooperation is central to this new form of evolution. Cultural advances can be shared by all humans.

Trading in primitive societies

Although primitive societies engaged in frequent wars, they also cooperated through trade. Peter Watson, an English historian of ideas, believes that long-distance trade took place as early as 150,000 before the present. There is evidence that extensive trade in obsidian and flint took place during the stone age. Evidence for wide ranging prehistoric obsidian and flint trading networks has been found in North America. Ancient burial sites in Southeast Asia show that there too, prehistoric trading took place across very large distances. Analysis of jade jewelry from the Phillipines, Thailand, Maylasia and Viet Nam shows that the jade originated in Taiwan.

The invention of writing was prompted by the necessities of trade. In prehistoric Mesopotamia, clay tokens marked with simple symbols were used for accounting as early as 8,000 BC. Often these tokens were kept in clay jars, and symbols on the outside of the jars indicated the contents. About 3,500 BC, the use of such tokens and markings led to the development of pictographic writing in Mesopotamia, and this was soon followed by the cuneiform script, still using soft clay as a medium. The clay tablets were later dried and baked to ensure permanency. The invention of writing led to a great acceleration of human cultural evolution. Since ideas could now be exchanged and preserved with great ease through writing, new advances in technique could be shared by an ever larger cooperating community of humans. Our species became more and more successful as its genius for cooperation developed.

Gracilization and decreasing sexual dimorphism

Early ancestors of modern humans had a relatively heavy (robust) bone structure in relation to their height. This robust bone structure seems to have been favored by frequent combat. During their evolution, modern humans became less robust and more gracile. In other words, their skeletons became lighter in relation to their height. Simultaneously the height and weight of males became less different from the height and weight of females. These trends are generally interpreted as indicating that combat became less important as present-day humans evolved.

Ethics and growth of the social unit

Early religions tended to be centered on particular tribes, and the ethics associated with them were usually tribal in nature. However, the more cosmopolitan societies that began to form after the Neolithic agricultural revolution required a more universal code of ethics. It is interesting to notice that many of the great ethical teachers of human history, for example Moses, Socrates, Plato, Aristotle, Lao Tzu, Confucius, Buddha, and Jesus, lived at the time when the change to larger social units was taking place. Tribalism was no longer appropriate. A wider ethic was needed.

Today the size of the social unit is again being enlarged, this time enlarged to include the entire world. Narrow loyalties have become inappropriate and there is an urgent need for a new ethic - a global ethic. Loyalty to one's nation needs to be supplemented by a higher loyalty to humanity as a whole.

Interdependence in modern human society

All of the great upward steps in the evolution of life on earth have involved cooperation: Prokaryotes, the first living cells, can be thought of as cooperative communities of autocatylists; large, complex eukaryote cells are now believed to have evolved as cooperative communities of prokaryotes; multicellular organisms are cooperative communities of eukaryotes; multicellular organisms cooperate to form societies; and different species cooperate to form ecosystems. Indeed, James Lovelock has pointed out that the earth as a whole is a complex interacting system that can be regarded as a huge organism.

The enormous success of humans as a species is due to their genius for cooperation. The success of humans is a success of cultural evolution, a new form of evolution in which information is passed between generations, not in the form of DNA sequences but in the form of speech, writing, printing and finally electronic signals. Cultural evolution is built on cooperation, and has reached great heights of success as the cooperating community has become larger and larger, ultimately including the entire world.

Without large-scale cooperation, modern science would never have evolved. It developed as a consequence of the invention of printing, which allowed painfully gained detailed knowledge to be widely shared. Science derives its great power from concentration. Attention and resources are brought to bear on a limited problem until all aspects of it are understood. It would make no sense to proceed in this way if knowledge were not permanent, and if the results of scientific research were not widely shared. But today the printed word and the electronic word spread the results of research freely to the entire world. The whole human community is the repository of shared knowledge.

The achievements of modern society are achievements of cooperation. We can fly, but no one builds an airplane alone. We can cure diseases, but only through the cooperative efforts of researchers, doctors and medicinal firms. We can photograph and understand distant galaxies, but the ability to do so is built on the efforts of many cooperating individuals.

An isolated sponge cell can survive, but an isolated human could hardly do so. Like an isolated bee, a human would quickly die without the support of the community. The comfort and well-being that we experience depends on far-away friendly hands and minds, since trade is global, and the exchange of ideas is also global.

Finally, we should be conscious of our cooperative relationships with other species. We could not live without the bacteria that help us to digest our food. We could not live without the complex communities of organisms in the soil that convert dead plant matter into fertile topsoil. We could not live without plants at the base of the food chain, but plants require pollination, and pollination frequently requires insects. An intricate cooperative network of inter-species relationships is necessary for human life, and indeed necessary for all life. Competition plays a role in evolution, but the role of cooperation is greater.

Two sides of human nature

Looking at human nature, both from the standpoint of evolution and from that of everyday experience, we see the two faces of Janus; one face shines radiantly; the other is dark and menacing. Two souls occupy the human breast, one warm and friendly, the other murderous. Humans have developed a genius for cooperation, the basis for culture and civilization; but they are also capable of genocide; they were capable of massacres during the Crusades, capable of genocidal wars against the Amerinds, capable of the Holocaust, of Hiroshima, of the killing-fields of Cambodia, of Rwanda, and of Darfur

As an example of the two sides of human nature, we can think of Scandinavia. The Vikings were once feared throughout Europe. The Book of Common Prayer in England contains the phrase "Protect us from the fury of the Northmen!". Today the same people are so peaceful and law-abiding that they can be taken as an example for how we would like a future world to look. Human nature has the possibility for both kinds of behavior depending on the circumstances. This being so, there are strong reasons to enlist the help of education and religion to make the bright side of human nature win over the dark side. Today, the mass media are an important component of education, and thus the mass media have a great responsibility for encouraging the cooperative and constructive side of human nature rather than the dark and destructive side.

Suggestions for further reading

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Chapter 12

AGAINST THE INSTITUTION OF WAR

As we start the 21st century and the new millennium, our scientific and technological civilization seems to be entering a period of crisis. Today, for the first time in history, science has given to humans the possibility of a life of comfort, free from hunger and cold, and free from the constant threat of infectious disease. At the same time, science has given us the power to destroy civilization through thermonuclear war, as well as the power to make our planet uninhabitable through pollution and overpopulation. The question of which of these alternatives we choose is a matter of life or death to ourselves and our children.

Science and technology have shown themselves to be double-edged, capable of doing great good or of producing great harm, depending on the way in which we use the enormous power over nature, which science has given to us. For this reason, ethical thought is needed now more than ever before. The wisdom of the world's religions, the traditional wisdom of humankind, can help us as we try to insure that our overwhelming material progress will be beneficial.

The crisis of civilization, which we face today, has been produced by the rapidity with which science and technology have developed. Our institutions and ideas adjust too slowly to the change. The great challenge which history has given to our generation is the task of building new international political structures, which will be in harmony with modern technology. At the same time, we must develop a new global ethic, which will replace our narrow loyalties by loyalty to humanity as a whole.

In the long run, because of the enormously destructive weapons, which have been produced through the misuse of science, the survival of civilization can only be insured if we are able to abolish the institution of war.

While in earlier epochs it may have been possible to confine the effects of war mainly to combatants, in our own century the victims of war have increasingly been civilians, and especially children. For example, according to Quincy Wright's statistics, the First and Second World Wars together cost the lives of 26 million soldiers, but the toll in civilian lives was much larger: 64 million.

Since the Second World War, despite the best efforts of the U. N., there have been over 150 armed conflicts; and, if civil wars are included, there are on any given day an average of 12 wars somewhere in the world. In the conflicts in Indo-China, the proportion of civilian victims was between 80% and 90%, while in the Lebanese civil war some sources state that the proportion of civilian casualties was as high as 97%.

Civilian casualties often occur through malnutrition and through diseases, which would be preventable in normal circumstances. Because of the social disruption caused by war, normal supplies of food, safe water and medicine are interrupted, so that populations become vulnerable to famine and epidemics. In the event of a catastrophic nuclear war, starvation and disease would add greatly to the loss of life caused by the direct effects of nuclear weapons.

The indirect effects of war are also enormous. Globally, preparations for war interfere seriously with the use of tax money for constructive and peaceful purposes. Today, despite the end of the Cold War, the world spends roughly a trillion (i.e. a million million) US dollars each year on armaments. This enormous flood of money, which is almost too large to imagine, could have been used instead for urgently needed public health measures.

The World Health Organization lacks funds to carry through an anti-malarial program on as large a scale as would be desirable, but the entire program could be financed for less than the world spends on armaments in a single day. Five hours of world arms spending is equivalent to the total cost of the 20-year WHO campaign, which resulted in the eradication of smallpox. For every 100,000 people in the world, there are 556 soldiers, but only 85 doctors. Every soldier costs an average of 20,000 US dollars per year, while the average spent per year on education is only 380 US dollars per school-aged child. With a diversion of funds consumed by three weeks of military spending, the world could create a sanitary water supply for all its people, thus eliminating the cause of almost half of all human illness.

A new and drug-resistant form of tuberculosis has recently become widespread, and is increasing rapidly in the former Soviet Union. In order to combat this new form of tuberculosis, and in order to prevent its spread to Western Europe, WHO needs 450 million US dollars, an amount equivalent to 4 hours of world arms spending. By using this money to combat tuberculosis in the former Soviet Union, WHO would be making a far greater contribution to global peace and stability than is made by spending the money on armaments.

Figure 12.1: *The World Health Organization could carry out its vitally important work much more effectively if it were given more money.*

Today's world is one in which roughly ten million children die each year from diseases related to poverty. Besides this enormous waste of young lives through malnutrition and preventable disease, there is a huge waste of opportunities through inadequate education. The rate of illiteracy in the 25 least developed countries is 80%, and the total number of illiterates in the world is estimated to be 800 million. Meanwhile every 60 seconds the world spends roughly 2 million U. S. dollars on armaments.

It is plain that if the almost unbelievable sums now wasted on armaments were used constructively, most of the pressing problems now facing humanity could be solved, but today the world spends more than 20 times as much per year on weapons as it does on development.

Because the world spends 1.7 thousand billion dollars each year on armaments, it follows that very many people make their living from war. This is the reason why it is correct to speak of war as a social institution, and also the reason why war persists, although everyone realizes that it is the cause of much of the suffering that inflicts humanity. We know that war is madness, but it persists. We know that it threatens the future survival of our species, but it persists, entrenched in the attitudes of historians, newspaper editors and television producers, entrenched in the methods by which politicians finance their campaigns, and entrenched in the financial power of arms manufacturers, entrenched also in the ponderous and costly hardware of war, the fleets of warships, bombers, tanks, nuclear missiles and so on.

Science cannot claim to be guiltless: In Eisenhower's farewell address, he warned of the increasing power of the industrial-military complex, a threat to democratic society. If he were making the same speech today, he might speak of the industrial-military-scientific complex. Since Hiroshima, we have known that new knowledge is not always good. There is a grave danger that nuclear weapons will soon proliferate to such an extent that they will be available to terrorists and even to the Mafia. Chemical and biological weapons also constitute a grave threat. The eradication of smallpox in 1979 was a triumph of medical science combined with international cooperation. How sad it is to think that military laboratories cultivate smallpox and that the disease may soon be reintroduced as a biological weapon!

The institution of war seems to be linked to a fault in human nature, to our tendency to exhibit altruism towards members of our own group but aggression towards other groups if we perceive them to be threatening our own community. This tendency, which might be called "tribalism", was perhaps built into human nature by evolution during the long prehistory of our species, when we lived as hunter-gatherers in small genetically homogeneous tribes, competing for territory on the grasslands of Africa. However, in an era of nerve gas and nuclear weapons, the anachronistic behavior pattern of tribal altruism and intertribal aggression now threatens our survival.

Fortunately, our behavior is only partly determined by inherited human nature. It is also, and perhaps to a larger extent, determined by education and environment; and in spite of all the difficulties just mentioned, war has been eliminated locally in several large regions of the world. Taking these regions as models, we can attempt to use the same methods to abolish war globally. For example, war between the Scandinavian nations would be unthinkable today, although the region once was famous for its violence. Scandinavia is especially interesting as a model for what we would like to achieve globally, because it is a region in which it has been possible not only to eradicate war, but also poverty; and at the same time, death from infectious disease has become a rarity in this region.

If we consider the problem of simultaneously eliminating poverty, war and frequent death from infectious disease, we are lead inevitably to the problem of population stabilization. At the time when poverty, disease and war characterized Scandinavia, the average fertility in the region was at least 6 children per woman-life. Equilibrium was maintained at this high rate of fertility, because some of the children died from disease without leaving progeny, and because others died in war. Today, poverty and war are gone from the Nordic countries, and the rate of premature death from infectious disease is very low. The simultaneous elimination of poverty, disease and war would have been impossible in Scandinavia if the rate of fertility had not fallen to the replacement level. There would then have been no alternative except for the population to grow, which it could not have continued to do over many centuries without environmental degradation, bringing with it the recurrence of poverty, disease and war.

In Scandinavia today, democratic government, a high level of education, economic prosperity, public health, high social status for women, legal, economic and educational equality for women, a low birth rate, and friendly cooperation between the nations of the region are mutually linked in loops of cause and effect. By contrast, we can find other regions of the world where low status of women, high birth rates, rapidly increasing population, urban slums, low educational levels, high unemployment levels, poverty, ethnic conflicts and the resurgence of infectious disease are equally linked, but in a vicious circle. The three age-old causes of human suffering, poverty, infectious disease and war are bound together by complex causal relationships involving also the issues of population stabilization and woman's rights. The example of Scandinavia shows us that it is possible to cure all these diseases of society; but to do so we must address all of the problems simultaneously.

Scandinavia was once a region that was famous for its violence. Today, war within Scandinavia would be unthinkable. This fact demonstrates the maliability of human nature. Under changed circumstances, and with changed education, people who were once extremely violent have become very peaceful. Scandinavia's low birth-rate has contributed to this transition.

Abolition of the institution of war will require the construction of structures of international government and law to replace our present anarchy at the global level. Today's technology has shrunken the distances, which once separated nations; and our present system of absolutely sovereign nation-states has become both obsolete and dangerous.

Professor Elie Kedourie of the University of London has given the following definition of nationalism: "..a doctrine invented in Europe at the beginning of the 19th century. It pretends to supply a criterion for the determination of the unit of population proper to enjoy a government exclusively its own, for the legitimate exercise of power in the state, and for the right organization of a society of states. Briefly, the doctrine holds that humanity is naturally divided into nations, that nations are known by certain characteristics which can be ascertained, and that the only legitimate type of government is national self-government."

A basic problem with this doctrine is that throughout most of the world, successive waves of migration, conquest and intermarriage have left such a complicated ethnic mosaic that attempts to base political divisions on ethnic homogeneity often meet with trouble. In Eastern Europe, for example, German-speaking and Slavic-speaking peoples are mixed together so closely that the Pan-German and Pan-Slavic movements inevitably clashed over the question of who should control the regions where the two populations lived side by side. This clash was one of the main causes of the First World War.

Similarly, when India achieved independence from England, a great problem arose in the regions where Hindus and Moslems lived side by side; and even Gandhi was unable to prevent terrible violence from taking place between the two communities. This problem is still present, and it has been made extremely dangerous by the acquisition of nuclear weapons by India and Pakistan.

More recently, nationalist movements in Asia and Africa have derived their force and popularity from a reaction against the years of European political and economic domination. Thus, at first sight, they seem to deserve our sympathy and support. However, in building states, the new nationalists have often used hate for outsiders as mortar. For example, Israel is held together by hostility towards its Arab neighbors, while the Pan-Arab movement is held together by hostility towards Israel; and in this inflamed political climate of mutual fear and hatred, even clandestine nuclear weapons appear to either side to be justified.

A basic problem rooted in nationalist mythology exists in the concept of sanctions, which treat nations as if they were individuals. We punish nations as a whole by sanctions, even when only the leaders are guilty, even though the burdens of the sanctions often fall most heavily on the weakest and least guilty of the citizens, and even though sanctions often have the effect of uniting the citizens of a country behind the guilty leaders.

It is becoming increasingly clear that the concept of the absolutely sovereign nation-state is an anachronism in a world of thermonuclear weapons, instantaneous communication and economic interdependence. Probably our best hope for the future lies in developing the United Nations into a World Federation. The strengthened United Nations should have a legislature with the power to make laws which are binding on individuals, and the ability to arrest and try individual political leaders for violations of these laws. The World Federation should also have the military and legal powers necessary to guarantee the human rights of ethnic minorities within nations.

A strengthened UN would need a reliable source of income to make the organization less dependent on wealthy countries, which tend to give support only to those interventions of which they approve. A promising solution to this problem is the so-called "Tobin tax", named after the Nobel-laureate economist James Tobin of Yale University. Tobin proposed that international currency exchanges should be taxed at a rate between 0.1 and 0.25%. He believed that even this extremely low rate of taxation would have the effect of damping speculative transactions, thus stabilizing the rates of exchange between currencies. When asked what should be done with the proceeds of the tax, Tobin said, almost as an afterthought, "Let the United Nations have it". The volume of money involved in international currency transactions is so enormous that

Figure 12.2: *Today, the existence of all-destroying modern weapons makes war prohibitively dangerous. If human civilization is to survive, the institution of war must be abolished. This will require effective governance at the global level. The United Nations must be strengthened and given many times the amount of money that it presently has. The UN must also be given the power to make laws that are binding on individuals.*

even the tiny tax proposed by Tobin would provide the World Federation with between 100 billion and 300 billion dollars annually. By strengthening the activities of various UN agencies, such as WHO, UNESCO and FAO, the additional income would add to the prestige of the United Nations and thus make the organization more effective when it is called upon to resolve international political conflicts.

A federation is, by definition, a limited union of states, where the federal government has the power to make laws which are binding on individuals, but where the laws are confined to interstate matters, and where all powers not expressly delegated to the federal government are reserved for the several states. In other words, in a federation, each of the member states runs its own internal affairs according to its own laws and customs; but in certain agreed-on matters, where the interests of the states overlap, authority is specifically delegated to the federal government.

For example, if the nations of the world considered the control of narcotics to be a matter of mutual concern; if they agreed to set up a commission with the power to make laws preventing the growing, refinement and distribution of harmful drugs, and with the power to arrest individuals for violating those laws, then we would have a world federation in the area of narcotics control.

If, in addition, the world community considered terrorism to be a matter of mutual concern; if an international commission were also set up with the power to make global anti-terrorist laws, and to arrest individuals violating those laws, then we would have a world federation with somewhat broader powers. If the community of nations decided to give the federal authority the additional power to make laws defining the rights and obligations of multinational corporations, and the power to arrest individuals violating those laws, then we would have a world federation with still broader powers; but these powers would still be carefully defined and limited.

In 1998, in Rome, representatives of 120 countries signed a statute establishing a Permanent International Court, with jurisdiction over war crimes and genocide. Four years were to pass before the necessary ratifications were gathered, but by Thursday, April 11, 2002, 66 nations had ratified the Rome agreement, 6 more than the 60 needed to make the court permanent. The jurisdiction of the Permanent International Court is at present limited to a very narrow class crimes. The global community will have a chance to see how the court works in practice, and in the future, the community may decide to broaden its jurisdiction.

In setting up a federation, the member states can decide which powers they wish to delegate to it; and all powers not expressly delegated are retained by the individual states. We are faced with the problem of constructing a new world order which will preserve the advantages of local self-government while granting certain carefully-chosen powers to larger regional or global authorities. Which things should be decided locally, or regionally, and which globally?

In the future, overpopulation and famine are likely to become increasingly difficult and painful problems in several parts of the world. Since various cultures take widely different attitudes towards birth control and family size, the problem of population stabilization seems to be one which should be solved locally. At the same time, aid for local family planning programs, as well as famine relief, might appropriately come from global agencies, such as WHO and FAO. With respect to large-scale migration, it would be unfair for a country which has successfully stabilized its own population, and which has eliminated poverty within its own borders, to be forced to accept a flood of migrants from regions of high fertility. Therefore the extent of immigration should be among the issues to be decided locally.

Security, and controls on the manufacture and export of armaments will require an effective authority at the global level. It should also be the responsibility of the international community to intervene to prevent gross violations of human rights. Since the end of the Cold War, the United Nations has more and more frequently been called upon to send armed forces to troubled parts of the world. In many instances, these calls for U. N. intervention have been prompted by clear and atrocious violations of human rights, for example by "ethnic cleansing" in Bosnia and by genocide in Rwanda. In the examples just named, the response of the United Nations would have been much more effective, and many lives would have been saved, if the action which was finally taken had come sooner. Long and complex diplomatic negotiations were required to muster the necessary political and physical forces needed for intervention, by which time the original problems had become much more severe. For this reason, it has been suggested that the U. N. Secretary General, the Security Council and the General Assembly ought to have at their disposal a permanent, highly trained and highly mobile emergency force, composed of volunteers from all nations. Such an international police force would be able to act rapidly to prevent gross violations of human rights or other severe breaches of international law.

In evaluating the concept of an international police force directly responsible to the United Nations, it is helpful to examine the way in which police act to enforce laws and to prevent violence and crime at local and national levels. Within a community which is characterized by good government, police are not highly armed, nor are they very numerous. Law and order are not maintained primarily by the threat of force, but by the opinion of the vast majority of the citizens that the system of laws is both just and necessary. Traffic stops when the signal light is red and moves when it is green whether or not a policeman is present, because everyone understands why such a system is necessary. Nevertheless, although the vast majority of the citizens in a well-governed community support the system of laws and would never wish to break the law, we all know that the real world is not heaven. The total spectrum of human nature includes evil as well as a good. If there were no police at all, and if the criminal minority were completely unchecked, every citizen would be obliged to be armed. No one's life or property would be safe. Robbery, murder and rape would flourish.

Within a society with a democratic and just government, whose powers are derived from the consent of the governed, a small and lightly armed force of police is able to maintain the system of laws. One reason why this is possible has just been mentioned - the force of public opinion. A second reason is that the law acts on individuals. Since obstruction of justice and the murder of policemen both rank as serious crimes, an individual criminal is usually not able to organize massive resistance against police action.

Edith Wynner, one of the pioneers of the World Federalist movement, lists the following characteristics of police power in a well-governed society:

1. "A policeman operates within a framework of organized government having legislative, executive and judicial authority operating on individuals. His actions are guided by a clearly stated criminal code that has the leg-

islative sanction of the community. Should he abuse the authority vested in him, he is subject to discipline and court restraint."

2. "A policeman seeing a fight between two men does not attempt to determine which of them is in the right and then help him beat up the one he considers wrong. His function is to restrain violence by both, to bring them before a judge who has authority to determine the rights of the dispute, and to see that the court's decision is carried out."

3. "In carrying out his duties, the policeman must apprehend the suspected individual without jeopardizing either the property or the lives of the community where the suspect is to be arrested. And not only is the community safeguarded against destruction of property and loss of life but the rights of the suspect are also carefully protected by an elaborate network of judicial safeguards."

Edith Wynner also discusses the original union of the thirteen American colonies, which was a confederation, analogous to the present United Nations. This confederation was found to be too weak, and after eleven years it was replaced by a federation, one of whose key powers was the power to make and enforce laws which acted on individuals. George Mason, one of the architects of the federal constitution of the United States, believed that "such a government was necessary as could directly operate on individuals, and would punish those only whose guilt required it", while James Madison (another drafter of the U. S. federal constitution) remarked that the more he reflected on the use of force, the more he doubted "the practicability, the justice and the efficacy of it when applied to people collectively, and not individually". Finally, Alexander Hamilton, in his "Federalist Papers", discussed the confederation with the following words: "To coerce the states is one of the maddest projects that was ever devised... Can any reasonable man be well disposed towards a government, which makes war and carnage the only means of supporting itself - a government that can exist only by the sword? Every such war must involve the innocent with the guilty. This single consideration should be enough to dispose every peaceable citizen against such a government... What is the cure for this great evil? Nothing, but to enable the... laws to operate on individuals, in the same manner as those of states do."

The United Nations is at present a confederation rather than a federation, and thus it acts by attempting to coerce states, a procedure which Alexander Hamilton characterized as "one of the maddest projects that was ever devised". Whether this coercion takes the form of economic sanctions, or whether it takes the form of military intervention, the practicability, the justice and the efficacy of the UN's efforts are hampered because they are applied to people collectively and not individually. It is obvious that the United Nations actions to stop aggression of one state against another in the Korean War and in the Gulf War fail to match the three criteria for police action listed above. What is the cure for this great evil? “Nothing”, Hamilton tells us, “but to enable the laws to act on individuals, in the same manner as those of states do.”

Historically, confederations have always proved to be too weak; but federations have on the whole been very successful, mainly because a federation has the power to make laws which act on individuals. At the same time, a federation aims at leaving as many powers as possible in the hands of local authorities. Recent examples of federations include the United States of America, the United States of Brazil, the United States of Mexico, the United States of Venezuela, the Argentine Nation, the Commonwealth of Australia, the Dominion of Canada, the Union of South Africa, Switzerland, the Union of Soviet Socialist Republics and the European Federation. Thus we are rich in historical data on the strengths and weaknesses of federations, and we can make use of this data as we attempt to construct good government at the global level.

Looking towards the future, we can perhaps foresee a time when the United Nations will have been converted to a federation and given the power to make international laws which are binding on individuals. Under such circumstances, true international law enforcement will be possible, incorporating all of the needed safeguards for lives and property of the innocent. One can hope for a future world where the institution of war will be abolished, and where public opinion will support international law to such an extent that a new Hitler or a future Melosovic will not be able to organize large-scale resistance to arrest, a world where international law will be seen by all to be just, impartial and necessary, a well-governed global community within which each person will owe his or her ultimate loyalty to humanity as a whole.

Besides a humane, democratic and just framework of international law and governance, we urgently need a new global ethic, - an ethic where loyalty to family, community and nation will be supplemented by a strong sense of the brotherhood of all humans, regardless of race, religion or nationality. Schiller expressed this feeling in his “Ode to Joy”, the text of Beethoven’s Ninth Symphony. Hearing Beethoven’s music and Schiller’s words, most of us experience an emotion of resonance and unity with its message: All humans are brothers and sisters - not just some - all! It is almost a national anthem of humanity. The feelings which the music and words provoke are similar to patriotism, but broader. It is this sense of a universal human family, which we need to cultivate in education, in the mass media, and in religion.

Educational reforms are urgently needed, particularly in the teaching of history. As it is taught today, history is a chronicle of power struggles and war,

Figure 12.3: *This painting shows a debate during the drafting of the Constitution of the United States. After achieving independence from England, the 13 former colonies became a confederation. However, this proved to be too weak, and in 1788, a federal constitution was ratified. Under the Federal Constitution of the United States, Congress has the power to make laws that are binding on individuals. This is th most important power of federations, and the reason why they are so successful.*

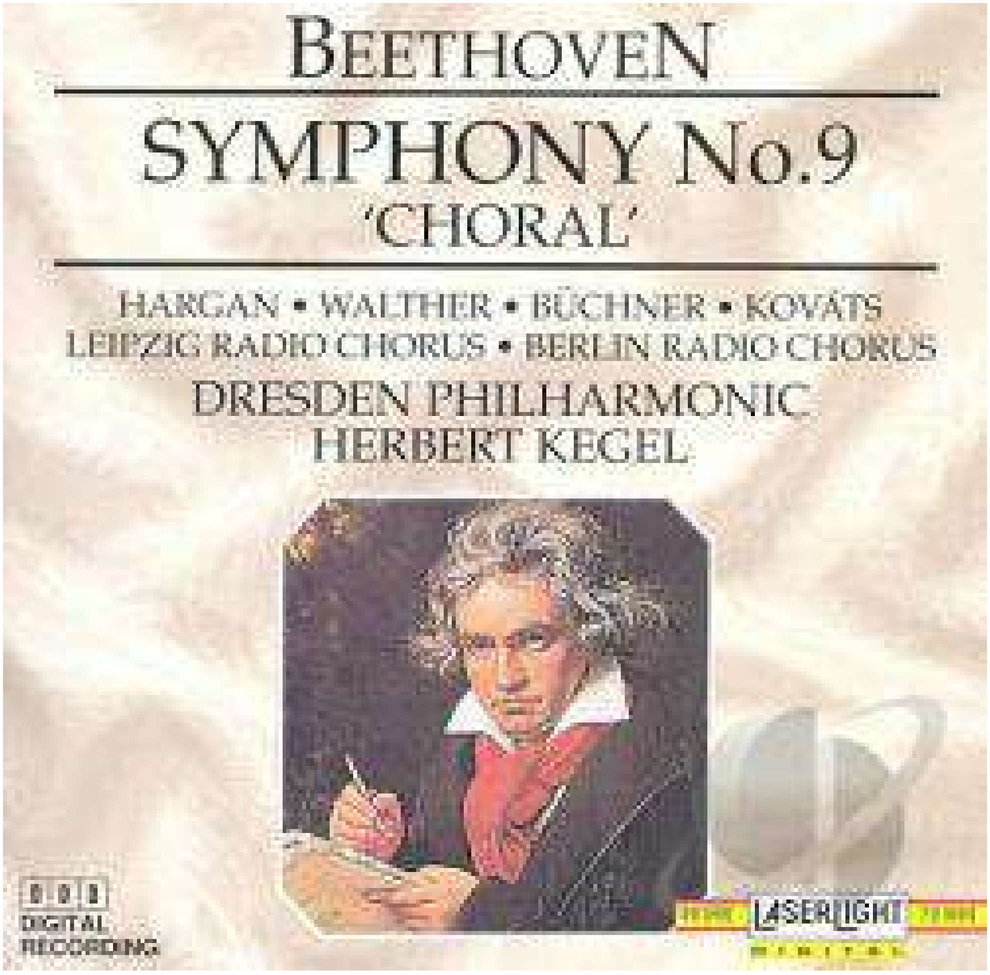

Figure 12.4: *Beethoven's 9th symphony is almost a national anthem of humanity, All people belong to a great family. Not just some. ALL!.*

told from a biased national standpoint. Our own race or religion is superior; our own country is always heroic and in the right.

We urgently need to replace this indoctrination in chauvinism by a reformed view of history, where the slow development of human culture is described, giving adequate credit to all those who have contributed. Our modern civilization is built on the achievements of ancient cultures. China, India, Mesopotamia, ancient Egypt, Greece, the Islamic world, Christian Europe, and Jewish intellectual traditions all have contributed. Potatoes, corn and squash are gifts from the American Indians. Human culture, gradually built up over thousands of years by the patient work of millions of hands and minds, should be presented to students of history as a precious heritage - far too precious to be risked in a thermonuclear war.

In the teaching of science too, reforms are needed. Graduates in science and technology should be conscious of their responsibilities. They must resolve never to use their education in the service of war, or in any way which might be harmful to society or to the environment.

In modern societies, mass media play an extremely important role in determining behavior and attitudes. This role can be a negative one when the media show violence and enemy images, but if used constructively, the mass media can offer a powerful means for creating international understanding. If it is indeed true that tribalism is part of human nature, it is extremely important that the mass media be used to the utmost to overcome the barriers between nations and cultures. Through increased communication, the world's peoples can learn to accept each other as members of a single family.

Finally, let us turn to religion, with its enormous influence on human thought and behavior. Christianity, for example, offers a strongly stated ethic, which, if practiced, would make war impossible. In Mathew, the following passage occurs: "Ye have heard it said: Thou shalt love thy neighbor and hate thy enemy. But I say unto you: Love your enemies, bless them that curse you, do good to them that hate you, and pray for them that spitefully use you and persecute you."

This seemingly impractical advice, that we should love our enemies, is in fact of the greatest practicality, since acts of unilateral kindness and generosity can stop escalatory cycles of revenge and counter-revenge such as those which characterize the present conflict in the Middle East and the recent troubles of Northern Ireland. However, Christian nations, while claiming to adhere to the ethic of love and forgiveness, have adopted a policy of "massive retaliation", involving systems of thermonuclear missiles whose purpose is to destroy as much as possible of the country at which the retaliation is aimed. It is planned that entire populations shall be killed in a "massive retaliation", innocent children along with the guilty politicians. The startling contradiction between what the Christian nations profess and what they do was obvious even before the advent of nuclear weapons, at the time when Leo Tolstoy, during his last years, was exchanging letters with a young Indian lawyer in South Africa. In one of his letters to Gandhi, Tolstoy wrote:

"The whole life of the Christian peoples is a continuous contradiction between that which they profess and the principles on which they order their lives, a contradiction between love accepted as the law of life, and violence, which is recognized and praised, acknowledged even as a necessity."

"This year, in the spring, at a Scripture examination at a girls' high school in Moscow, the teacher and the bishop present asked the girls questions on the Commandments, and especially on the sixth. After a correct answer, the bishop generally put another question, whether murder was always in all cases forbidden by God's law; and the unhappy young ladies were forced by previous instruction to answer 'Not always' - that murder was permitted in war and in the execution of criminals. Still, when one of these unfortunate young ladies (what I am telling is not an invention but a fact told to me by an eye witness) after her first answer, was asked the usual question, if killing was always sinful, she, agitated and blushing, decisively answered 'Always', and to the usual sophisms of the bishop, she answered with decided conviction that killing was always forbidden in the Old Testament and forbidden by Christ, not only killing but every wrong against a brother. Notwithstanding all his grandeur and arts of speech, the bishop became silent and the girl remained victorious."

As everyone knows, Gandhi successfully applied the principle of non-violence to the civil rights struggle in South Africa, and later to the political movement, which gave India its freedom and independence. The principle of non-violence was also successfully applied by Martin Luther King, and by Nelson Mandela. It is perhaps worthwhile to consider Gandhi's comment on the question of whether the end justifies the means: "The means may be likened to a seed", Gandhi wrote, "and the end to a tree; and there is the same inviolable connection between the means and the end as there is between the seed and the tree." In other words, a dirty method produces a dirty result; killing produces more killing; hate leads to more hate. Everyone who reads the newspapers knows that this is true. But there are positive feedback loops as well as negative ones. A kind act produces a kind response; a generous gesture is returned; hospitality results in reflected hospitality. Buddhists call this principle of reciprocity "the law of karma".

The religious leaders of the world have the opportunity to contribute importantly to the solution of the problem of war. They have the opportunity to powerfully support the concept of universal human brotherhood, to build bridges between religious groups, to make intermarriage across ethnic bound-

Figure 12.5: *Count Leo Tolstoy said "The sharpest of all contradictions can be seen between the government's professed faith in the Christian law of the brotherhood of all humankind, and the military laws of the state, which force each young man to prepare himself for enmity and murder, so that each must be simultaneously a Christian and a gladiator."*

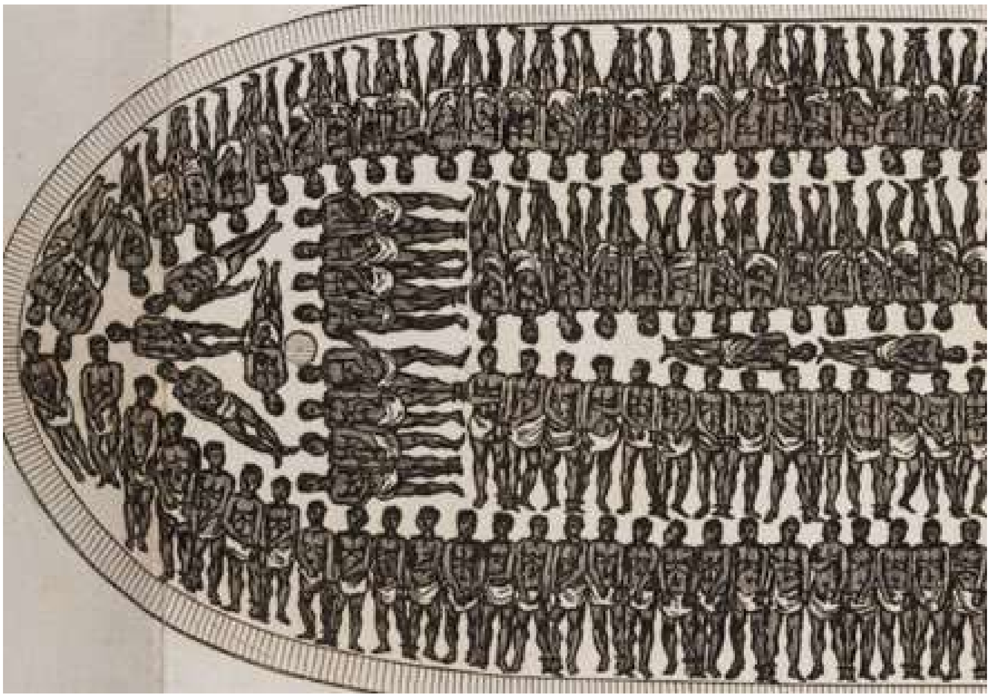

Figure 12.6: *Diagram of a slave shop. We can hope and work for a time when war, like slavery, will exist only as a dark memory, fading into the past.*

aries easier, and to soften the distinctions between communities. If they fail to do this, they will have failed humankind at a time of crisis.

It is useful to consider the analogy between the institution of war and the institution of slavery. We might be tempted to say, "There has always been war, throughout human history; and war will always continue to exist." As an antidote for this kind of pessimism, we can think of slavery, which, like war, has existed throughout most of recorded history. The cultures of ancient Egypt, Greece and Rome were all based on slavery, and, in more recent times, 13 million Africans were captured and forced into a life of slavery in the New World. Slavery was as much an accepted and established institution as war is today. Many people made large profits from slavery, just as arms manufacturers today make enormous profits. Nevertheless, in spite of the weight of vested interests, slavery has now been abolished throughout most of the world.

Today we look with horror at drawings of slave ships, where human beings were packed together like cord-wood; and we are amazed that such cruelty could have been possible. Can we not hope for a time when our descendants, reading descriptions of the wars of the twentieth century, will be equally amazed that such cruelty could have been possible? If we use them constructively, the vast resources now wasted on war can initiate a new era of happiness and prosperity for the family of man. It is within our power to let this happen. The example of the men and women who worked to rid the world of slavery can give us courage as we strive for a time when war will exist only as a dark memory fading into the past.

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Appendix A

HIROSHIMA: A SILENCE BROKEN

Book review: “Hiroshima, August 6, 1945, a Silence Broken”

Why the book is important

The nuclear destruction of Hiroshima was a tragedy in itself, but its larger significance is that it started a nuclear arms race which today threatens to destroy human society and much of the biosphere.

Sokka Gakkai

Sokka Gakkai is a large Nichirin Buddhist religious group. Its 12 million members are centered primarily in Japan, but Sokka Gokkai International (SGI) has groups in 192 countries. In Japanese, the words “Sokka Gakkai” mean “Value-Creating Education”. The organization was started by two Japanese educators, Tsunisaburo Makiguchi and Josei Toda, both of whom were imprisoned by their government during World War II because of their opposition to militarism. Makaguchi died as a result of his imprisonment, but Josei Toda went on to found a large and vigorous educational organization dedicated to culture, humanism, world peace and nuclear abolition.

The Toda Declaration and Daisaku Ikeda’s Proposals

In 1957, before a cheering audience of 50,000 young Sokka Gakkai members, Josei Toda declared nuclear weapons to be an absolute evil. He said that their possession is criminal under all circumstances, and he called the young people

Figure A.1: *In 1957, before a cheering audience of 50,000 young Sokka Gakkai members, Josei Toda declared nuclear weapons to be an absolute evil. He said that their possession is criminal under all circumstances, and he called on the young people present to work untiringly to rid the world of all nuclear weapons. Source: SGI International*

present to work untiringly to rid the world of all nuclear weapons.

Toda was the mentor of Daisaku Ikeda, the first president SGI. Every year, President Ikeda issues a Peace Proposal, calling for international understanding and dialogue, as well as nuclear abolition, and outlining practical steps by which he believes these goals may be achieved. In his 2013 Peace Proposal, Ikeda, noted that 2015 will be the 70th anniversary of the destruction of Hiroshima, and he proposed that the NPT review conference should take place in Hiroshima, rather that in New York. He proposed that this should be followed by "an expanded global summit for a nuclear-weapon-free world"

The Hiroshima Peace Committee and the last remaining hibakushas

In Japanese the survivors of injuries from the nuclear bombing of Hiroshima and Nagasaki are called "hibakushas". Over the years, the Sokka Gakkai Hiroshima Peace Committee has published many books containing their testimonies. The most recent of these books, "A Silence Broken", contains the testimonies of 14 men, now all in their late 70's or in their 80's, who are among the last few remaining hibakushas. All 14 of these men have kept silent until

Figure A.2: *It was like a scene from hell. Source: SGI International.*

now because of the prejudices against hibakusha in Japan, where they and their children are thought to be unsuitable as marriage partners because of the effects of radiation. But now, for various reasons, they have chosen to break their silence. Many have chosen to speak now because of the Fukushima disaster.

The testimonies of the hibakushas give a vivid picture of the hell-like horrors of the nuclear attack on the civilian population of Hiroshima, both in the short term and in the long term. For example, Shigeru Nonoyama, who was 15 at the time of the attack, says: "People crawling out from crumbled houses started to flee. We decided to escape to a safe place on the hill. We saw people with melted ears stuck to their cheeks, chins glued to their shoulders, heads facing in awkward positions, arms stuck to bodies, five fingers joined together and grab nothing. Those were the people fleeing. Not merely a hundred or two, The whole town was in chaos."

"I saw the noodle shop's wife leg was caught under a fallen pole, and a fire was approaching. She was screaming, 'Help me!Help me!' There were no soldiers, no firefighters. I later heard that her husband had cut off his wife's leg with a hatchet to save her."

"Each and every scene was hell itself. I couldn't tell the difference between the men and the women. Everybody had scorched hair, burned hair, and terrible burns. I thought I saw a doll floating in a fire cistern, but it was a baby. A wife trapped under her fallen house was crying, 'Dear, please help me, help me!' Her husband had no choice but to leave her in tears."

"...I hovered between life and death for three months, from August to

Figure A.3: *Burned beyond recognition. Source: SGI International.*

Figure A.4: *Memories of August 6. Source: SGI International.*

Figure A.5: *The effects lasted a lifetime. Source: SGI International.*

Figure A.6: *After the bombing. Source: SGI International.*

October. When a fly landed on a festering wound, it would bleed white maggots in a few days. My mother shooed away the flies through the night with a fan through the night. She must have been desperately determined not to lose any more sons or daughters. My dangling skin dried and turned hard, like paper. My mother picked off the dried skin. She made a cream of straw ash and cooking oil, and applied it to my burnt head, face and fingertips, turning me black..."

The testimonies of the other hibakushas are equally horrifying.

The postwar nuclear arms race

On August 29, 1949, the USSR exploded its first nuclear bomb. It had a yield equivalent to 21,000 tons of TNT, and had been constructed from Pu-239 produced in a nuclear reactor. Meanwhile the United Kingdom had begun to build its own nuclear weapons.

The explosion of the Soviet nuclear bomb caused feelings of panic in the United States, and President Truman authorized an all-out effort to build superbombs using thermonuclear reactions - the reactions that heat the sun and stars. On October 31, 1952, the first US thermonuclear device was exploded at Eniwetok Atoll in the Pacific Ocean. It had a yield of 10.4 megatons, that is to say it had an explosive power equivalent to 10,400,000 tons of TNT. Thus the first thermonuclear bomb was five hundred times as powerful as the bombs that had devastated Hiroshima and Nagasaki. The Soviet Union and the United Kingdom were not far behind.

In 1955 the Soviets exploded their first thermonuclear device, followed in

1957 by the UK. In 1961 the USSR exploded a thermonuclear bomb with a yield of 58 megatons. A bomb of this size, two thousand times the size of the Hiroshima bomb, would destroy a city completely even if it missed it by 50 kilometers. France tested a fission bomb in 1966 and a thermonuclear bomb in 1968. In all about thirty nations contemplated building nuclear weapons, and many made active efforts to do so.

Because the concept of deterrence required an attacked nation to be able to retaliate massively even though many of its weapons might be destroyed by a preemptive strike, the production of nuclear warheads reached insane heights, driven by the collective paranoia of the Cold War. More than 50,000 nuclear warheads were produced worldwide, a large number of them thermonuclear. The collective explosive power of these warheads was equivalent to 20,000,000,000 tons of TNT, i.e., 4 tons for every man, woman and child on the planet, or, expressed differently, a million times the explosive power of the bomb that destroyed Hiroshima. Today, the collective explosive power of all the nuclear weapons in the world is about half that much, but still enough to destroy human society.

There are very many cases on record in which the world has come very close to a catastrophic nuclear war. One such case was the Cuban Missile Crisis. Robert McNamara, who was the US Secretary of Defense at the time of the crisis, had this to say about how close the world came to a catastrophic nuclear war: “I want to say, and this is very important: at the end we lucked out. It was luck that prevented nuclear war. We came that close to nuclear war at the end. Rational individuals: Kennedy was rational; Khrushchev was rational; Castro was rational. Rational individuals came that close to total destruction of their societies. And that danger exists today.”

A number of prominent political and military figures (many of whom have ample knowledge of the system of deterrence, having been part of it) have expressed concern about the danger of accidental nuclear war. Colin S. Gray, Chairman, National Institute for Public Policy, expressed this concern as follows: “The problem, indeed the enduring problem, is that we are resting our future upon a nuclear deterrence system concerning which we cannot tolerate even a single malfunction”. Bruce G. Blair (Brookings Institute) has remarked that “It is obvious that the rushed nature of the process, from warning to decision to action, risks causing a catastrophic mistake”... “This system is an accident waiting to happen.”

As the number of nuclear weapon states grows larger, there is an increasing chance that a revolution will occur in one of them, putting nuclear weapons into the hands of terrorist groups or organized criminals. Today, for example, Pakistan’s less-than-stable government might be overthrown, and Pakistan’s nuclear weapons might end in the hands of terrorists. The weapons might then be used to destroy one of the world's large coastal cities, having been brought into the port by one of numerous container ships that dock every day, a number far too large to monitored exhaustively. Such an event might trigger a large-scale nuclear conflagration.

Recent research has shown that a large-scale nuclear war would be an ecological catastrophe of enormous proportions, producing very large-scale famine through its impact on global agriculture, and making large areas of the world permanently uninhabitable through long-lived radioactive contamination.

How do these dangers look in the long-term perspective? Suppose that each year there is a certain finite chance of a nuclear catastrophe, let us say 1 percent. Then in a century the chance of a disaster will be 100 percent, and in two centuries, 200 percent, in three centuries, 300 percent, and so on. Over many centuries, the chance that a disaster will take place will become so large as to be a certainty. Thus by looking at the long-term future, we can see that if nuclear weapons are not entirely eliminated, civilization will not survive.

We will do well to remember Josei Toda's words: "Nuclear weapons are an absolute evil. Their possession is criminal under all circumstances"

Appendix B

BOOK REVIEW: THE PATH TO ZERO

The Path to Zero, by Richard Falk and David Krieger

This book ought to be required reading for college students everywhere in the world, and also for decision-makers. It shakes us out of our complacency and makes us realize that widespread, immediate and dedicated public action is urgently needed if we are to save human civilization and the biosphere from a thermonuclear catastrophe. The book is published by Paradigm Publishers, 2845 Wilderness Place, Boulder, CO 80301, USA. (www.paradigmpublishers.com) On the back cover there are endorsements, with which I entirely agree, by Archbishop Desmond Tutu and David Ellsberg.

" We are greatly privileged, like flies on the wall, to join this conversation between two remarkable stalwarts. Richard Falk and David Krieger, in the campaign for a nuclear-free world. It is unconscionable that so many of us seem to accept the prospect of our 'mutually assured destruction', the immoral massacre of millions of civilians, and to view with equanimity such a gross violation of international law. Falk and Krieger discuss persuasively and cogently the folly of reliance on nuclear weapons that can cause apocalyptic devastation. If we want to survive in a habitable world, then we have no choice: we must heed, and do so urgently, these lovers of mankind." Archbishop Desmond Tutu, Nobel Peace Laureate

" In 'The Path to Zero', Falk and Krieger engage in a stunningly eloquent dialogue on a range of nuclear dangers, and our common responsibility to put an end to them. This is urgent reading for citizens, scientists, policy-makers and political leaders, actually for anyone who cares about the future of civilization and life on earth", Daniel Ellsberg, Whistleblower

Other enthusiastic endorsements come from Jonathan Schell, Commander Robert Green and Maude Barlow.

The book has ten chapters: 1 The Nuclear Age; 2 Nuclear Deterrence; 3 Nuclear Proliferation; 4 Nuclear Arms Control and Nuclear Disarmament; 5 Nuclear Weapons and Militarism; 6 Nuclear Weapons and Nuclear Energy; 7 Nuclear Weapons and International Law; 8 Nuclear Weapons, Culture and Morality; 9 Nuclear Weapons and Democracy; 10 The Path to Zero.

The two authors

Richard Falk is Albert G. Milbank Professor of International Law and Practice Emeritus at Princeton, where he was a member of the faculty for 40 years. Since 2002 he has been a research professor at the University of California-Santa Barbara. He has been Special Rapporteur on Occupied Palestine for the UN Human Rights Council since 2008, and served on a panel of experts appointed by the President of the UN General Assembly, 2008-2009. He is the author or editor of numerous books, including " Legality and Legitimacy in Global Affairs" (Oxford 2012).

David Krieger is a Founder of the Nuclear Age Peace Foundation, and has served as President of the Foundation since 1982. Under his leadership, the Foundation has initiated many innovative projects for building peace, strengthening international law, abolishing nuclear weapons, and empowering peace leaders. Among other leadership positions, he is one of 50 Councilors from around the world on the World Future Council. He is the author and editor of numerous books and articles related to achieving peace in the Nuclear Age. A graduate of Occidental College, he holds MA and PhD degrees in political science from the University of Hawaii.

Flaws in the concept of nuclear deterrence

In discussing the concept of nuclear deterrence, the two authors emphasize the fact that it violates the fundamental ethical principles of every major religion. Dr. Krieger comments:

Krieger: " Who are we? What kind of culture would be content to base its security on threatening to murder hundreds of millions of innocent people?"

The two authors also point out that the idea of deterrence is an unproved theory, based on the assumption that accidents will not happen, and that

Figure B.1: *Richard Falk*

leaders are always rational. In fact, we know historically that the world has come extremely near to accidental nuclear war on very numerous occasions, and there are also many historical instances of irrational behavior by leaders. This cannot continue indefinitely without a catastrophe.[1]

The illegality of nuclear weapons

As Dr. Krieger and Prof. Falk point out, the threat or use of nuclear weapons violates international law. The fact that planning an aggressive war or conducting one is a crime according to the Nuremberg Principles is discussed. The two authors also review in detail the 1996 Advisory Opinion of the International Court of Justice, which was asked by the UN General Assembly and the World Health Organization to rule on the legality of the threat or use of nuclear weapons. The ICJ ruled that under almost all circumstances, the threat or use of nuclear weapons would be illegal. The only possible exception was the case where a country might be under attack and its very survival threatened. The Court gave no ruling on this extreme case. Finally, the ICJ ruled unanimously that states possessing nuclear weapons have an obligation to get rid of them within a short time-frame.

[1]See: http://www.cadmusjournal.org/article/issue-4/flaws-concept-nuclear-deterrance

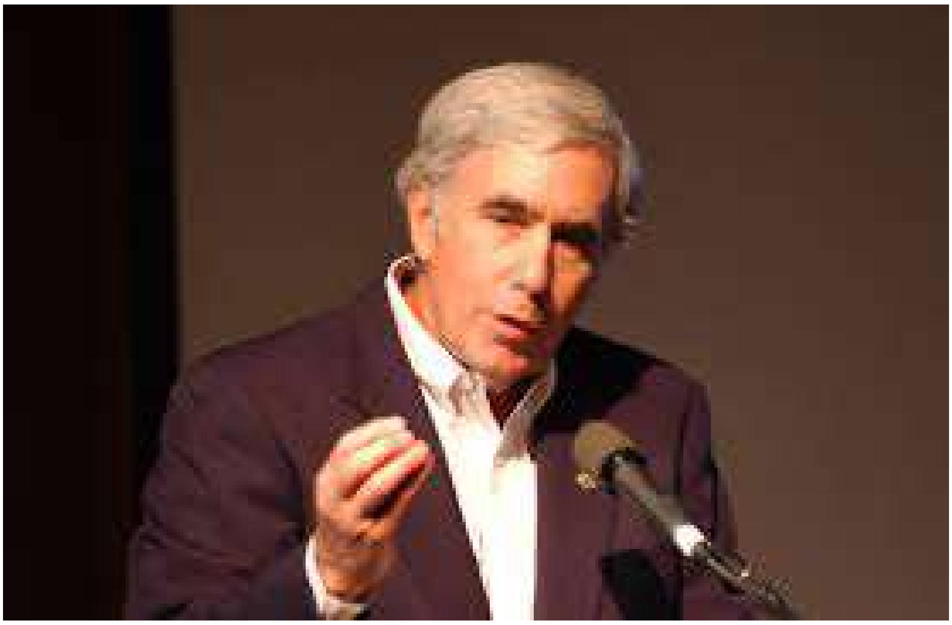

Figure B.2: *David Krieger*

Falk: " It may be time for the General Assembly to put this question to the ICJ: What legal consequences arise from the persistent failure of the nuclear weapon states to fulfill their obligations under Article VI of the NPT? In my view, the nonnuclear states have also been irresponsible in not insisting on on mutuality of respect in the nonproliferation setting. It may be up to civil society actors to bring wider attention to this disrespect for the vital norms of international law..." [2]

Colonialism and exceptionalism

Falk: " We need to remember that the expansion of Europe at the expense of the non-Western world rested on violence and the superiority of European weaponry and strategic logistics, including naval power. This link between Western militarism and historical ascendancy is, in my view, one of the deep reasons why there is such an irrational attachment to nuclear weaponry, mak-

[2]http://www.icj-cij.org/docket/files/93/7407.pdf
http://www.currentconcerns.ch/index.php?id=711
https://www.wagingpeace.org/author/john-avery/
http://human-wrongs-watch.net/2015/03/27/tactical-nuclear-weapons-in-europe-the-dangers-are-very-great-today/
http://www.countercurrents.org/avery250514.htm

ing it very difficult to renounce as the supreme expression of political violence."

Krieger: " I would like to add that there is a general orientation in much of Western society to subordinate international law to geopolitical desire, in other words, not to allow international law to be a limiting factor in seeking geopolitical advantage. International law is thus applied when useful and ignored when self-interest and convenience dictate. This is a striking manifestation of the double standards that have served the interests of the powerful in both the colonial and postcolonial worlds."

The Nuclear Non-Proliferation Treaty

In discussing the Nuclear Non-Proliferation Treaty, Prof. Falk and Dr. Krieger point out that that it has several serious flaws: It is unsymmetrical, giving a special status to the nuclear weapons states, and forbidding all others to possess these weapons. The treaty encourages the " peaceful" use of nuclear energy, which in practice opens the door to acquisition of nuclear weapons by many nations and which exposes the world to radioactive fallout from accidents like Chernobyl and Fukushima, and very long-term dangers from radioactive wastes. Finally, membership in the NPT is not universal. Here are some comments by the two authors:

Falk: " In my view, the failure of the nuclear weapon states to pursue nuclear disarmament over a period of more than forty years, despite the injunction to do so by the International Court of Justice, is a material breach of the NPT that would give any party the option of pronouncing the treaty void."

Krieger: " It would be wonderful to see a strong and concerted effort by non-nuclear-weapon states to challenge the nuclear weapons club. I think that the most effective thing that such states could do would be to start the process of negotiating a nuclear weapons convention and, if necessary, to do it without the nuclear weapon states."

Falk: " My proposal is a two-year ultimatum by as many nonnuclear states as possible, threatening to withdraw from the NPT unless serious nuclear disarmament negotiations get underway."

Dr. Krieger is not in complete agreement with Prof. Falk regarding such an ultimatum. He feels that even though it is flawed in many ways, the NPT is still so valuable that its continuation ought not to be threatened.

Krieger: " One of the great problems with the NPT is that it encourages the peaceful use of nuclear energy, which actually opens the door to nuclear weapons proliferation. It ends up making the treaty work against itself. Of course, Israel is not a party to the treaty, nor are India and Pakistan. This demonstrates a fundamental weakness of international law, that is, the exemption of nations that do not sign a treaty from the law. This would be unworkable in domestic law, and it is equally so in international law."

Krieger: " The nuclear plant operators are willing to downplay for short-term gain the catastrophic risks that are involved in the use of nuclear reactors to boil water. They are wiling to generate wastes that will adversely affect the health and well-being of untold generations to follow us on the planet. The tragedy is that governments embrace and support this industry, demonstrating that they also do not place the interests of their people and the future at the forefront of their planning and decision making."

http://www.baselpeaceoffice.org/article/global-wave-2015-and-peace-planet-un-nuclear-non-proliferation-conference

No first use; no hair-trigger alerted missiles

In their concluding chapter, the two authors agree that a No First Use declaration could be a useful first step. Prof. Falk comments:

Falk: " What conceivable justification, consistent with a deterrence rationale for the retention of nuclear weapons, is there for not assuring other governments that the United States will only use such weaponry in retaliation a prior attack with nuclear weaponry? It is rather clear that such a declaration, especially if backed up by non-nuclear deployments, would both give the United States some new claim to leadership with respect to the weaponry and exert enormous psychological pressure on other nuclear weapon states to follow the American lead."

This, of course, could be linked to taking all nuclear weapons systems off hair-trigger alert, which is probably the most important first step towards avoiding the catastrophe of an accidental nuclear war. Dr Krieger comments:

Krieger: " Those responsible for maintaining nuclear arsenals on hair-trigger alert are delusional if they think that it can be maintained indefinitely without dire consequences."

Developments since the publication of the book

Since the publication of Prof. Falk and Dr. Krieger's book in 2012, several events have taken place which the authors probably would have discussed if they had occurred earlier. For example, on 2 April, 2013, the Arms Trade Treaty was passed by a massive majority by a direct vote in the UN General Assembly. The ATT had remained blocked for more than 10 years in the consensus-bound Conference on Disarmament in Geneva. Its passage gives us hope that a Nuclear Weapons Convention can similarly be passed by a direct vote in the UN General Assembly, where the vast majority of nations are in favor of the complete abolition of nuclear weapons. Even if bitterly opposed by the nuclear weapons states, a Nuclear Weapons Convention would have great normative value.
http://www.cadmusjournal.org/article/issue-6/arms-trade-treaty-opens-new-possibilities-un

Another development which Prof. Falk and Dr. Krieger would certainly have discussed, had it occurred earlier, is an heroic law suit by the Republic of the Marshall Islands, suing the nuclear weapons states for violation of Article VI of the Nuclear Non-Proliferation Treaty. In fact Dr. Krieger and his organization, the Nuclear Age Peace Foundation, are actively supporting the Marshall Islands in this David-versus-Goliath-like law suit.
http://www.wagingpeace.org/tag/marshall-islands/

Finally, the two authors would probably have discussed the hubris of Washington's power-holders in threatening war with both Russia and China. The effect of this colossally misguided US action has been to firmly unite China and Russia. In fact the BRICS countries, with their vast resources, are now moving away from using the dollar as a reserve currency for international trade. The probable effect will be the collapse of the already-strained US economy, and as a consequence, the fall of the US Empire. Prof. Falk and Dr. Krieger both wonder whether they have been too America-centric in their discussions of nuclear abolition. The probable fall of the United States from its present position of global hegemony may mean that US leadership will not, in the future, be the key to nuclear abolition.
http://www.countercurrents.org/roberts110515.htm
http://www.truth-out.org/opinion/item/19734-hubris-versus-wisdom
http://beforeitsnews.com/alternative/2014/04/wolfowitz-doctrine-us-plans-for-russia-2945824.html

Some conclusions

When the Cold War ended in 1991, many people heaved a sigh of relief and concluded that they no longer had to worry about the threat of a nuclear Armageddon. Prof. Falk and Dr. Krieger show us that this comforting belief is entirely false, that the dangers are greater than ever before, and that it is vital to bring this fact to the urgent attention of today's young people, who were born long after the tragic nuclear destruction of Hiroshima and Nagasaki, or perhaps even born after the end of the Cold War.

Ultimately, the complete abolition of nuclear weapons is linked with a change of heart, the replacement of narrow nationalism by loyalty to humanity as a whole, and the replacement of militarism by a just and enforcible system of international law.

Suggestions for further reading:

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" Legality of the Threat or Use of Nuclear Weapons." Advisory Opinion of the International Court of Justice, The Hague, July 8, 1996. http://www.icj-cij.org/docket/files/93/7407.pdf

McCloy-Zorin Accords. " Joint Statement of Agreed Principles for Disarmament Negotiations," signed on September 20, 1961, unanimously adopted by the United Nations General Assembly on December 20, 1961.

Model Nuclear Weapons Convention. " Convention on the Prohibition of the Development, Testing, Production, Stockpiling, Transfer, Use and Threat of Use of Nuclear Weapons and their Elimination, April 2007."
http://www.inesap.org/publications/nuclear-weapons-convention

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Russell-Einstein Manifesto, issued in London, July 9, 1955,
http://www.pugwash.org/about/manifesto.htm

Santa Barbara Declaration, " Reject Nuclear Deterrence: An Urgent Call to Action,"
http://www.wagingpeace.org/santa-barbara-declaration-reject-nuclear-deterrence-an-urgent-call-to-action/

Treaty on the Non-Proliferation of Nuclear Weapons, entered into force on March 5, 1970.
http://www.state.gov/www/global/arms/treaties/npt1.html

Vancouver Declaration. " Law's Imperative for the Urgent Achievement of a Nuclear-Weapon-Free World," Vancouver, Canada, March 21, 2011.
http://www.lcnp.org/wcourt/Feb2011VancouverConference/vancouverdeclaration.pdf

Appendix C

INTERNATIONAL DAY FOR THE TOTAL ELIMINATION OF NUCLEAR WEAPONS

What you can do as an individual

In the follow-up to the 2013 high-level meeting on nuclear disarmament, the United Nations General Assembly passed a resolution in which it declared 26 September the International Day for Total Elimination of Nuclear Weapons.[1] The first ever event will take place a month from now on 26 September, 2014. [2]

What can you, as an individual, do? You can plan an action to commemorate the day. You can write to your Prime Minister/President and/or Foreign Minister, to ask what your government plans to do to commemorate the day. You can ask your local parliamentarian, mayor and city council the same question. You can tell www.unfoldzero.org about your activities.

The Interparliamentary Union, with 167 members, passed a resolution in March, 2014, calling on its members to support the total elimination nof nuclear weapons: [3]

Why is the total elimination of nuclear weapons so urgent? Although somewhat reduced in numbers from the insane heights of the Cold War, the power of today's nuclear weapons is more than sufficient to destroy human

[1] http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/1com/1com13/resolutions/L6Rev1.pdf

[2] http://www.unfoldzero.org/

[3] http://www.ipu.org/conf-e/130/Res-1.htm
http://www.cbsnews.com/news/whos-minding-the-nuclear-weapons/
https://www.youtube.com/watch?v=y6WvXxMkBWg

civilization and much of the biosphere. Many of the weapons are on hair-trigger alert, meaning that those in charge of them have only minutes to decide whether a radar signal is a true or false report of an attack. Most of us alive today owe our existence to Lt. Col. Stanislav Petrov, who correctly reported such a warning as a computer error.

The system of mutal deterrence has been described as "an accident waiting to happen". In the long run, the small yearly chance that a catastrophic accident will occur will build up into a certainty of disaster. For example, even if the yearly chance of an accident occurring were as small 1 percent (and it is certainly larger than that), over several centuries the probability accidental thermonuclear war will become a near certainty. We have been extremely lucky so far, but in the long run civilization and nuclear weapons cannot co-exist.

Just as the generals and politicians who started World War I seem not to have comprehended what a war with machine guns and long-range artillery would be like, so our leaders today seem not to have an imaginative idea of what a thermonuclear war would be like. Promising to defend their populations, they do no such thing, but instead they put us at risk of total annihilation.

Today, it is up to each individual to work with courage and dedication to put an end to nuclear insanity.

Appendix D

REMEMBER YOUR HUMANITY

The Russell-Einstein Manifesto

The year 2015 marked the 60th anniversary of the Russell-Einstein Manifesto, which contains the following words: "There lies before us, if we choose, continual progress in happiness, knowledge and wisdom. Shall we, instead, choose death, because we cannot forget our quarrels? Remember your humanity, and forget the rest. If you can do so, the way lies open to a new Paradise. If you cannot, there lies before you the risk of universal death."

The background for the Russell-Einstein Manifesto is as follows: In March, 1954, the United States had tested a hydrogen bomb at the Bikini Atoll in the Pacific Ocean. It was 1,000 times more powerful than the Hiroshima bomb. The Japanese fishing boat, the Lucky Dragon, was 130 kilometers from the Bikini explosion, but the radioactive fallout from the test killed one crew member, and made all the others seriously ill.

In England, Professor Joseph Rotblat, a Polish scientist who had resigned from the Manhattan Project for moral reasons when it became clear that Germany would not develop nuclear weapons, was asked to appear on a BBC program to discuss the Bikini test. He was asked to discuss the technical aspects of H-bombs, while the Archbishop of Canterbury and the philosopher, Lord Bertrand Russell, were asked to discuss the moral aspects.

Rotblat had become convinced that the Bikini bomb must have involved a third stage, in which fast neutrons from the hydrogen thermonuclear reaction produced fission in an outer casing of ordinary uranium. Such a bomb would produce enormous amounts of highly dangerous fallout, and Rotblat became extremely worried about the possibly fatal effects on all living things if large numbers of such bombs were ever used in a war. He confided his worries to

Bertrand Russell, whom he had met on the BBC program.

After discussing the Bikini test and its radioactive fallout with Joseph Rotblat, Lord Russell became concerned for the future of the human gene pool. After consulting a number of leading physicists, including Albert Einstein, he wrote what came to be known as the Russell-Einstein Manifesto.

Russell was convinced that in order for the Manifesto to have maximum impact, Einstein's signature would be absolutely necessary; but as Russell was flying from Italy to France, the pilot announced to the passengers that Einstein had just died. Russell was crushed by the news, but when he arrived at his hotel in Paris, he found waiting for him a letter from Einstein and his signature on the document. Signing the Manifesto had been the last act of Einstein's life. Others who signed were Max Born, Percy W. Bridgman, Leopold Infeld, Frederic Joliot-Curie, Hermann J. Muller, Linus Pauling, Cecil F. Powell, Joseph Rotblat, Hideki Yukawa and Bertrand Russell. All of them, except Infeld and Rotblat, were Nobel Laureates.

On July 9, 1955, with Rotblat in the chair, Russell read the Manifesto to a packed press conference. The document contains the words: "Here then is the problem that we present to you, stark and dreadful and inescapable: Shall we put an end to the human race, or shall mankind renounce war?... There lies before us, if we choose, continual progress in happiness, knowledge and wisdom. Shall we, instead, choose death because we cannot forget our quarrels?..." Lord Russell devoted much of the remainder of his life to working for the abolition of nuclear weapons.[1]

In 1957, with the Russell-Einstein Manifesto as a background, a group of scientists from both sides of the Cold War met in the small village of Pugwash, Nova Scotia. The meeting was held at the summer residence of the Canadian-American financier and philanthropist Cyrus Eaton, who had given money for the conference. The aim of the assembled scientists was to reduce the danger of a catastrophic nuclear war.

From this small beginning, a series of conferences developed, in which scientists, especially physicists, attempted to work for peace, and tried to address urgent problems related to science. These conferences were called Pugwash Conferences on Science and World Affairs, taking their name from the small village in Nova Scotia where the first meeting was held. From the start, the main aim of the meetings was to reduce the danger that civilization would be destroyed in a thermonuclear war.

It can be seen from what has been said that the Pugwash Conferences began during one of the tensest periods of the Cold War, when communication between the Communist and Anti-communist blocks was difficult. During

[1] http://www.umich.edu/ pugwash/Manifesto.html

this period, the meetings served the important purpose of providing a forum for informal diplomacy. The participants met, not as representatives of their countries, but as individuals, and the discussions were confidential.

This method of operation proved to be effective, and the initial negotiations for a number of important arms control treaties were aided by Pugwash Conferences. These include the START treaties, the treaties prohibiting chemical and biological weapons, the Nuclear Nonproliferation Treaty (NPT), and the Comprehensive Test Ban Treaty (CTBT). Former Soviet President Gorbachev has said that discussions with Pugwash scientists helped him to conclude that the policy of nuclear confrontation was too dangerous to be continued.

Over the years, the number of participants attending the annual Pugwash Conference has grown, and the scope of the problems treated has broadened. Besides scientists, the participants now include diplomats, politicians, economists, social scientists and military experts. Normally the number attending the yearly conference is about 150.

Besides plenary sessions, the conferences have smaller working groups dealing with specific problems. There is always a working group aimed at reducing nuclear dangers, and also groups on controlling or eliminating chemical and biological weapons. In addition, there may now be groups on subjects such as climate change, poverty, United Nations reform, and so on.

Invitations to the conferences are issued by the Secretary General to participants nominated by the national groups. The host nation usually pays for the local expenses, but participants finance their own travel. Besides the large annual meeting, the Pugwash organization also arranges about ten specialized workshops per year, with 30-40 participants each. Although attendance at the conferences and workshops is by invitation, everyone is very welcome to join one of the national Pugwash groups. The international organization's website is at www.pugwash.org.

In 1995, the Nobel Peace Prize was awarded jointly to Prof. Joseph Rotblat and to Pugwash Conferences on Science and World Affairs as an organization, " ...for their efforts to diminish the part played by nuclear arms in international politics and in the longer run to eliminate such arms." The award was made 50 years after the tragic destruction of Hiroshima and Nagasaki.

In his acceptance speech, Sir Joseph Rotblat (as he soon became) emphasized the same point that has been made by the Russell-Einstein Manifesto, that war itself must be eliminated in order to free civilization from the danger of nuclear destruction. The reason for this is that knowledge of how to make nuclear weapons can never be forgotten. Even if they were eliminated, these weapons could be rebuilt during a major war. Thus the final abolition of nuclear weapons is linked to a change of heart in world politics and to the abolition of war.

"The quest for a war-free world", Sir Joseph concluded, "has a basic purpose: survival. But if, in the process, we can learn to achieve it by love rather than by fear, by kindness rather than compulsion; if in the process we can learn to combine the essential with the enjoyable, the expedient with the benevolent, the practical with the beautiful, this will be an extra incentive to embark on this great task. Above all, remember your humanity"

I vividly remember the ceremony in Oslo when the 1995 Nobel Peace Prize was awarded jointly to Sir Joseph and to Pugwash Conferences. About 100 people from the Pugwash organization were invited, and I was included because I was the chairman of the Danish National Pugwash Group. After the ceremony and before the dinner, local peace groups had organized a torchlight parade. It was already dark, because we were so far to the north, and snow was falling. About 3,000 people carrying torches marched through the city and assembled under Sir Joseph's hotel window, cheering and shouting "Rotblat! Rotblat! Rotblat!". Finally he appeared at the hotel widow, waved to the crowd and tried to say a few words. This would have been the moment for a memorable speech, but the acoustics were so terrible that we could not hear a word that he said. I later tried (without success) to persuade the BBC to make a program about nuclear weapons and about Sir Joseph's life, ending with the falling snow and the torch-lit scene.

The dangers are very great today

Although the Cold War has ended, the danger of a nuclear catastrophe is greater today than ever before. There are 16,300 nuclear weapons in the world today, of which 15,300 are in the hands of Russia and the United States. Several thousand of these weapons are on hair-trigger alert, meaning that whoever is in charge of them has only a few minutes to decide whether the signal indicating an attack is real, or an error. The most important single step in reducing the danger of a disaster would be to take all weapons off hair-trigger alert.

Bruce G. Blair, Brookings Institute, has remarked that "It is obvious that the rushed nature of the process, from warning to decision to action, risks causing a catastrophic mistake... This system is an accident waiting to happen." Fred Ikle of the Rand Corporation has written,"But nobody can predict that the fatal accident or unauthorized act will never happen. Given the huge and far-flung missile forces, ready to be launched from land and sea on on both sides, the scope for disaster by accident is immense... In a matter of seconds, through technical accident or human failure, mutual deterrence might thus collapse."

Although their number has been cut in half from its Cold War maximum, the total explosive power of today's weapons is equivalent to roughly half a million Hiroshima bombs. To multiply the tragedy of Hiroshima and Nagasaki by a factor of half a million changes the danger qualitatively. What is threatened today is the complete breakdown of human society.

There is no defense against nuclear terrorism. We must remember the remark of U.N. Secretary General Kofi Annan after the 9/11/2001 attacks on the World Trade Center. He said, "This time it was not a nuclear explosion". The meaning of his remark is clear: If the world does not take strong steps to eliminate fissionable materials and nuclear weapons, it will only be a matter of time before they will be used in terrorist attacks on major cities. Neither terrorists nor organized criminals can be deterred by the threat of nuclear retaliation, since they have no territory against which such retaliation could be directed. They blend invisibly into the general population.

Nor can a "missile defense system" prevent terrorists from using nuclear weapons, since the weapons can be brought into a port in any one of the hundreds of thousands of containers that enter on ships each year, a number far too large to be checked exhaustively.

As the number of nuclear weapon states grows larger, there is an increasing chance that a revolution will occur in one of them, putting nuclear weapons into the hands of terrorist groups or organized criminals. Today, for example, Pakistan's less-than-stable government might be overthrown, and Pakistan's nuclear weapons might end in the hands of terrorists. The weapons might then be used to destroy one of the world's large coastal cities, having been brought into the port by one of numerous container ships that dock every day. Such an event might trigger a large-scale nuclear conflagration.

Today, the world is facing a grave danger from the reckless behavior of the government of the United States, which recently arranged a coup that overthrew the elected government of Ukraine. Although Victoria Nuland's December 13 2013 speech talks much about democracy, the people who carried out the coup in Kiev can hardly be said to be democracy's best representatives. Many belong to the Svoboda Party, which had its roots in the Social-National Party of Ukraine (SNPU). The name was an intentional reference to the Nazi Party in Germany.[2]

It seems to be the intention of the US to establish NATO bases in Ukraine, no doubt armed with nuclear weapons. In trying to imagine how the Russians feel about this, we might think of the US reaction when a fleet of ships sailed to Cuba in 1962, bringing Soviet nuclear weapons. In the confrontation that followed, the world was bought very close indeed to an all-destroying nuclear

[2] http://www.informationclearinghouse.info/article37599.htm
http://www.thedailybeast.com/articles/2014/02/06/state-dept-official-caught-on-tape-fuck-the-eu.html

war. Does not Russia feel similarly threatened by the thought of hostile nuclear weapons on its very doorstep? Can we not learn from the past, and avoid the extremely high risks associated with the similar confrontation in Ukraine today?

Since we have recently marked the 100th anniversary of the outbreak of the First World War, it is appropriate to view the crisis in Ukraine against the background of that catastrophic event, which still casts a dark shadow over the future of human civilization. We must learn the bitter lessons which World War I has to teach us, in order to avoid a repetition of the disaster.

We can remember that the First World War started as a small operation by the Austrian government to punish the Serbian nationalists; but it escalated uncontrollably into a global disaster. Today, there are many parallel situations, where uncontrollable escalation might produce a world-destroying conflagration.

In general, aggressive interventions, in Iran, Syria, Ukraine, the Korean Peninsula and elsewhere, all present dangers for uncontrollable escalation into large and disastrous conflicts, which might potentially threaten the survival of human civilization.

Another lesson from the history of World War I comes from the fact that none of the people who started it had the slightest idea of what it would be like. Science and technology had changed the character of war. The politicians and military figures of the time ought to have known this, but they didn't. They ought to have known it from the million casualties produced by the use of the breach-loading rifle in the American Civil War. They ought to have known it from the deadly effectiveness of the Maxim machine gun against the native populations of Africa, but the effects of the machine gun in a European war caught them by surprise.

Few politicians or military figures today have any imaginative understanding of what a war with thermonuclear weapons would be like. Recent studies have shown that in a nuclear war, the smoke from firestorms in burning cities would rise to the stratosphere where it would remain for a decade, spreading throughout the world, blocking sunlight, blocking the hydrological cycle and destroying the ozone layer.

The effect on global agriculture would be devastating, and the billion people who are chronically undernourished today would be at risk. Furthermore, the tragedies of Chernobyl and Fukushima remind us that a nuclear war would make large areas of the world permanently uninhabitable because of radioactive contamination. A full-scale thermonuclear war would be the ultimate ecological catastrophe. It would destroy human civilization and much of the biosphere.

One can gain a small idea of the terrible ecological consequences of a nuclear war not only by thinking of the radioactive contamination that has made large areas near to Chernobyl and Fukushima uninhabitable, but also from the testing of hydrogen bombs in the Pacific, which continues to cause leukemia and birth defects in the Marshall Islands more than half a century later.

As we discussed above, the United States tested a hydrogen bomb at Bikini in 1954. Fallout from the bomb contaminated the island of Rongelap, one of the Marshall Islands 120 kilometers from Bikini. The islanders experienced radiation illness, and many died from cancer. Even today, half a century later, both people and animals on Rongelap and other nearby islands suffer from birth defects. The most common defects have been “jelly fish babies”, born with no bones and with transparent skin. Their brains and beating hearts can be seen. The babies usually live a day or two before they stop breathing.

A girl from Rongelap describes the situation in the following words: “I cannot have children. I have had miscarriages on seven occasions... Our culture and religion teach us that reproductive abnormalities are a sign that women have been unfaithful. For this reason, many of my friends keep quiet about the strange births that they have had. In privacy they give birth, not to children as we like to think of them, but to things we could only describe as ’octopuses’, ’apples’, ’turtles’ and other things in our experience. We do not have Marshallese words for these kinds of babies, because they were never born before the radiation came.”

The Republic of the Marshall Islands is suing the nine countries with nuclear weapons at the International Court of Justice at The Hague, arguing they have violated their legal obligation to disarm. The Guardian reports that “In the unprecedented legal action, comprising nine separate cases brought before the ICJ on Thursday, the Republic of the Marshall Islands accuses the nuclear weapons states of a ‘flagrant denial of human justice’. It argues it is justified in taking the action because of the harm it suffered.”

“The Pacific chain of islands, including Bikini Atoll and Enewetak, was the site of 67 nuclear tests from 1946 to 1958, including the ’Bravo shot’, a 15-megaton device equivalent to a thousand Hiroshima blasts, detonated in 1954. The Marshallese islanders say they have been suffering serious health and environmental effects ever since.”

“The island republic is suing the five ‘established’ nuclear weapons states recognized in the 1968 nuclear non-proliferation treaty (NPT), the US, Russia (which inherited the Soviet arsenal), China, France and the UK, as well as the three countries outside the NPT who have declared nuclear arsenals - India, Pakistan and North Korea, and the one undeclared nuclear weapons state, Israel.” The Republic of the Marshall Islands is not seeking monetary compensation, but instead it seeks to make the nuclear weapon states comply with their legal obligations under Article VI of the Nuclear Nonproliferation

Treaty and the 1996 ruling of the International Court of Justice.

On July 21, 2014, the United States filed a motion to dismiss the Nuclear Zero lawsuit that was filed by the Republic of the Marshall Islands (RMI) on April 24, 2014 in U.S. Federal Court. The U.S., in its move to dismiss the RMI lawsuit, does not argue that the U.S. is in compliance with its NPT disarmament obligations. Instead, it argues in a variety of ways that its non-compliance with these obligations is, essentially, justifiable, and not subject to the court's jurisdiction.[3]

The Nuclear Age Peace Foundation (NAPF) is a consultant to the Marshall Islands on the legal and moral issues involved in bringing this case. David Krieger, President of NAPF, upon hearing of the motion to dismiss the case by the U.S. responded, "The U.S. government is sending a terrible message to the world, that is, that U.S. courts are an improper venue for resolving disputes with other countries on U.S. treaty obligations. The U.S. is, in effect, saying that whatever breaches it commits are all right if it says so. That is bad for the law, bad for relations among nations, bad for nuclear non-proliferation and disarmament, and not only bad, but extremely dangerous for U.S. citizens and all humanity."

The RMI will appeal the U.S. attempt to reject its suit in the U.S. Federal Court, and it will continue to sue the 9 nuclear nations in the International Court of Justice. Whether or not the suits succeed in making the nuclear nations comply with international law, attention will be called to the fact the 9 countries are outlaws. In vote after vote in the United Nations General Assembly, the peoples of the world have shown how deeply they long to be free from the menace of nuclear weapons. Ultimately, the tiny group of power-hungry politicians must yield to the will of the citizens whom they are at present holding as hostages.

It is a life-or-death question. We can see this most clearly when we look at far ahead. Suppose that each year there is a certain finite chance of a nuclear catastrophe, let us say 2%. Then in a century the chance of survival will be 13.5%, and in two centuries, 1.8%, in three centuries, 0.25%, in 4 centuries, there would only be a 0.034% chance of survival and so on. Over many centuries, the chance of survival would shrink almost to zero. Thus by looking at the long-term future, we can clearly see that if nuclear weapons are not entirely eliminated, civilization will not survive.

Civil society must make its will felt. A thermonuclear war today would be not only genocidal but also omnicidal. It would kill people of all ages, babies, children, young people, mothers, fathers and grandparents, without any regard whatever for guilt or innocence. Such a war would be the ultimate

[3] http://www.truth-out.org/opinion/item/28997-bush-appointed-judge-dismisses-nuclear-zero-lawsuit-marshall-islands-to-appeal

ecological catastrophe, destroying not only human civilization but also much of the biosphere. Each of us has a duty to work with dedication to prevent it.

Appendix E

AN ARCTIC NUCLEAR WEAPONS FREE ZONE

An important and active element of the Non-Proliferation Regime has been the establishment of a growing number of Nuclear-Weapon-Free Zones (NWFZ). The major nuclear-weapon-free zones established so far, cover more than half of the world's landmass including some 75 % of all land outside of nuclear-weapon state territory and 99 % of the Southern Hemisphere land areas. They encompass 119 states (out of some 195) and 19 other territories with about 1.9 billion inhabitants. The establishment of more such zones is proposed. The Middle East is frequently mentioned as the possible next zone.

Another possible zone candidate that has been discussed for quite some time is the circumpolar Arctic which has now become an urgent issue, not primarily because of a specific political need but because of the current climate change.

The Arctic and the High North has for centuries been generally inaccessible for other than a few explorers. Since the 1950s, regular airlines passed above the surface, nuclear propelled submarines passed under the ice and a few icebreakers occasionally passed through the ice.

In recent years, however, the average world surface temperature has risen. The Arctic polar ice has for a number of subsequent summers been melting more than before. According to many experts, the northern polar sea, now covered by ice year around, may in a not too distant future become open waters first in the summers, and eventually on a permanent basis.

Should the Arctic sea turn unfrozen the year around, substantial new opportunities of great economic value would be available. Shipping between harbours in the Atlantic and the Pacific oceans shortcutting by the North Pole would spare time and cost. New areas could be opened up for large scale fishing.

Future exploitation of a more accessible Arctic would require international cooperation on a wide range of political, economic, navigational, and other matters. Disputes and competing or overlapping claims would have to be solved in an orderly and peaceful way. Militarization of the presence and activities should be avoided. Therefore, arms control measures should be instituted at an early stage, beginning with restricting weapons of mass destruction and the establishment of a nuclear-weapon-free zone in the region.

The early negotiation and establishment of a nuclear-weapon-free zone in the Arctic thus seems timely, urgent and very important. Historically, the negotiation and establishment of a NWFZ has proved to be time-consuming, requiring years and in some cases decades, and thus motivating immediate initiation of the process of establishing an Arctic NWFZ.

A first question is whether it would be possible to draft an Arctic nuclear-weapon-free zone treaty by just copying the Antarctic treaty of 1959. But the political and geographic differences between the two regions are too large to make such a simple procedure possible. Antarctica is an almost uninhabited continent not subject to any national jurisdiction. The Arctic region is primarily an ocean surrounded by inhabited land areas subject to national sovereignties.

But many lessons could be learned from the zones estBut many lessons could be learned from the zones established so far. In addition, a thorough discussion within the United Nations Disarmament Commission 1997-1999 resulted in a set of recommendations for zone-making unanimously endorsed by the UN General Assembly1. ablished so far. In addition, a thorough discussion within the United Nations Disarmament Commission 1997-1999 resulted in a set of recommendations for zone-making unanimously endorsed by the UN General Assembly.

The geographical scope of the zone has to be based upon the Arctic Circle which, however, has itself no political significance. The states to be invited to negotiate such a zone would be those having territory north of the circle, i.e. the eight states of Canada, Denmark (Greenland), Finland, Iceland, Norway, Russia, Sweden, and the USA (Alaska). However, a zone project with such geography will have to address issues having no historical precedents. Two of these states are nuclear-weapon states and six are non-nuclear-weapon states. Among the latter, four are members of the NATO alliance having a nuclear weapon role included in its strategic concept. In addition, the major part of the zone area would be ocean

The climate change and the possible turning of the Arctic from a mostly barren ice-desert into an attractive area for man has made international regulation of a number of issues urgently needed, e.g. security including conventional and non-conventional military matters, economic cooperation, exploitation of mineral resources, fishing, shipping and navigation, protection of the environment, and rights and participation of indigenous populations. International treaties covering these issues and possibly others will soon have to be negotiated. All such new agreements, an Arctic NWFZ included, should be coordinated and harmonized to avoid contradiction and overlap. Negotiation of an Arctic NWFZ would have to adapt to such a context, although initiated at an early stage.

Several existing zones were established step by step. States in a region met and negotiated the obligations and terms related to an envisaged NWFZ[1]. A treaty text was negotiated, agreed, and signed. An entry-into-force process followed that often lasted for many years during which time the zone was built up and consolidated. Considering the complicated geography of an Arctic zone, it is reasonable to suggest that such a zone would also be established that way. It should be noted that two steps were already taken.

One is the 1920 Treaty on Spitsbergen[2] article 9 of which prohibits the establishment of naval bases and fortifications in the area of application, "which may never be used for warlike purposes". Modern interpretation of this old-fashioned language implies that the Spitsbergen area should be considered a demilitarised zone and by implication also a nuclear-weapon-free zone.

The other step is the 1971 Sea-Bed Treaty prohibiting the parties to emplace "Nuclear Weapons and Other Weapons of Mass Destruction on the Sea-Bed and the Ocean Floor and in the Subsoil Thereof" including in the waste sea areas of the Arctic regardless of any future delimitation of the Arctic shelves.

Another potential step that was widely discussed in the years 1963-1991 but which never materialized was a Nordic European NWFZ. An official report on that zone proposal was issued in 1991[3]. This idea could be relevant again today as a step towards an Arctic zone. Further steps could be envisaged.

One step today could be to initiate a UN study by the Secretary General with the assistance of governmental experts to explore the many political, legal, geophysical, military and administrative issues involved.

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[1] A/54/42, Annex I: *Establishment of nuclear-weapon-free Zones on the basis of arrangements freely arrived at among the States of the region concerned.* The report was later unanimously endorsed by the UN General Assembly (A/RES/55/56 A).

[2] *League of Nations Treaty Series*, Vol. 2.

[3] *Nuclear-Weapon-Free Zone in the Nordic Area. Report from the Nordic Senior Officials Group.* Ministry of Foreign Affairs of Sweden. March 1991. The study of the group was based on preceding national studies.

Figure E.1: *The present reality: Exactly what we don't want! At present nuclear-armed submarines of both the USA and Russia regularly patrol Arctic waters, even colliding under the ice. (U.S. Navy photo by Chief Yeoman Alphonso Braggs).*

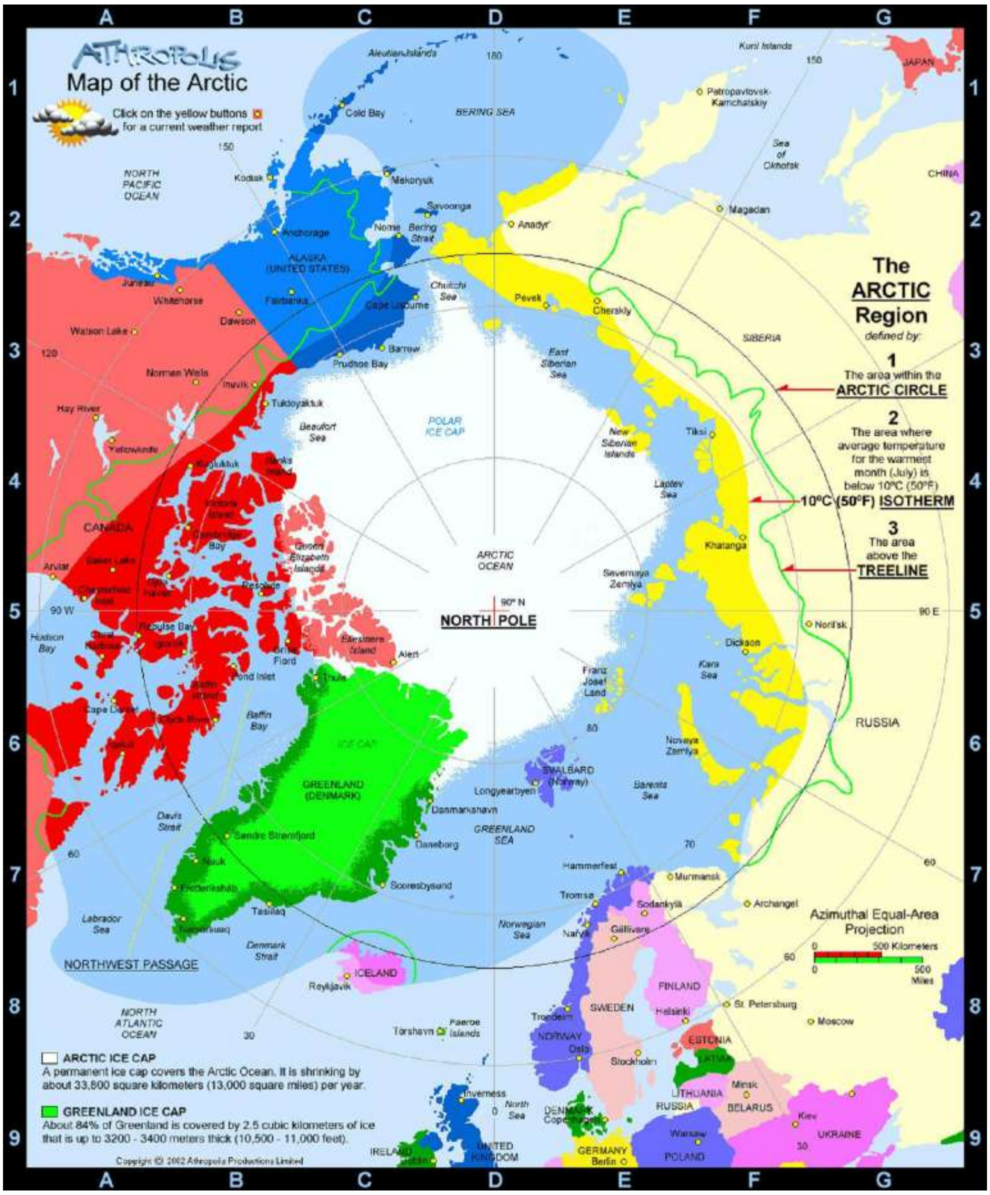

Figure E.2: *A political map of the Arctic region. Rights to some of the waterways are disputed.*

Figure E.3: *Polar sea ice is melting much faster than expected. The rapidly-warming climate of the Arctic threatens both the fragile ecology of the region and its indigenous peoples. At the same time it presages a massive geoeconomic shift to the north. (http://cos-webster.st.unh.edu)*

Call for an Arctic NWFZ

In August, 2009, the participants at at a conference in Copenhagen issued the following Call for an Arctic NWFZ:

We the participants in the Conference on an Arctic Nuclear-Weapon-Free Zone, held in Copenhagen 10-11 August 2009:

- *Recognizing* that polar-ice-cap melting, caused by climate change, increases the potential for greater human and economic activity as well as conflict in the Arctic region, making more urgent the establishment of non-military, cooperative mechanisms for environmental protection, adaptation and security;
- *Inspired* by promising new opportunities and political momentum for the achievement of a nuclear-weapon-free world;
- *Believing* that nuclear-weapon-free zones play an important role in building regional security and confidence in order to achieve a nuclear-weapon-free world;
- *Recognizing* the value of international treaties as instruments for building mutually beneficial collaborative arrangements and ensuring verification and compliance;
- *Welcoming* treaties prohibiting nuclear weapons in specific regions, including Antarctica (1959), Outer Space (1967), Sea-Bed (1971), Latin America and the Caribbean (1968), the South Pacific (1986), South East Asia (1995), Africa (1996), Mongolia (2000), and Central Asia (2006);
- *Encouraged* by the April 2009 resolution adopted by the Inter-Parliamentary Union, representing 150 national parliaments, calling for the establishment of additional Nuclear-Weapon-Free Zones;
- *Welcoming* international treaties which take additional steps to completely demilitarize geographic zones, such as the 1959 Antarctic Treaty;
- *Welcoming especially* the 1971 Seabed Treaty which prohibits the placement of nuclear weapons on the ocean floor including in the Arctic region;
- *Recognizing* that each region, including the Arctic, has its own unique security environment which requires creative, multifaceted negotiations in order to achieve the establishment of the desired Nuclear-Weapon-Free Zone;

- *Encouraged* by the May 2008 declaration of Illulissat in which the Foreign Ministers of the littoral states of the Arctic region agreed to work together to promote peaceful cooperation in the Arctic region, on the basis of international law, including the 1982 United Nations Convention on the Law of the Sea.

Recommend:

1. That governments and relevant sectors of civil society collaborate in developing the modalities for establishing a nuclear-weapon-free and demilitarized Arctic region;

2. That such collaboration should include active participation of, among others, indigenous and northern peoples, inhabitants of the region, parliamentarians, scientists, health professionals and academics;

3. That the aim of a Nuclear-Weapon-Free Arctic should be promoted in relevant environmental and development forums;

4. That the aim should also be promoted in relevant national and in- ternational political forums including, but not limited to, the United Nations, Arctic Council, Organization for Security and Cooperation in Europe, Nordic Council, North Atlantic Treaty Organization, Cooperative Security Treaty Organization (Tashkent Treaty), Non Proliferation Treaty Review Conferences and the Conference on Disarmament;

5. That countries in nuclear alliances be encouraged to reduce the role of nuclear weapons in their security doctrines in order to better facilitate the establishment of Nuclear-Weapon-Free Zones involving these countries, including in the Arctic region;

6. That countries in the Arctic region not possessing nuclear weapons (Canada, Denmark, Finland, Iceland, Norway, Sweden) take initial steps towards a Nuclear-Weapon-Free Zone in close cooperation with the United States and the Russian Federation;That countries in the Arctic region not possessing nuclear weapons (Canada, Denmark, Finland, Iceland, Norway, Sweden) take initial steps towards a Nuclear-Weapon-Free Zone in close cooperation with the United States and the Russian Federation;

7. That governments undertake steps to increase transparency and to redress negative impacts on inhabitants and the environment from military activities in the Arctic region including those in the past.

A Nordic Nuclear Weapon Free Zone

The governments of Denmark, Norway, Sweden Finland and Iceland are opposed to nuclear weapons, and there none stationed on Scandinavian territory. Therefore a Nordic Nuclear Weapon Free Zone is a possible first step towards an Arctic NWFZ.

The Nordic countries already fulfill two important criteria of NWFZ's - non-possession of nuclear weapons and non-stationing of nuclear weapons by any state within their zone. Regarding non-use or no threat of use against targets within the zone, we think that the nuclear weapons states would agree not to threaten to use their weapons against the Nordic countries.

In 1957, Denmark enacted a ban on nuclear weapons on its territories, and that ban is still in force, despite Danish membership in NATO. This demonstrates that membership of several Scandinavian countries in NATO is not a hindrance to the formation of a Nordic NWFZ. Further support for this view can be found in the precedent of the 2006 Semipalitinsk Treaty, which involves Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Several of the member states of the Semipalitinsk NWFZ are members of a treaty organization with Russia, the Tashkent Treaty, but this did not prevent them from signing the Semipalitinsk Treaty.

The idea of a Nordic NWFZ was first proposed by Nikolai Bulganin in1958. Bulganin's proposal was supported by President Kekkonen of Finland but it was initially rejected by the other Nordic countries. Kekkonen contin- ued to promote the idea of a Nordic NWFZ, but it took more than 20 years before other Nordic governments gave serious support to the idea.

In September 1980 when the Norwegian diplomat Jens Evensen suggested1958. Bulganin's proposal was supported by President Kekkonen of Finland but it was initially rejected by the other Nordic countries. Kekkonen contin- ued to promote the idea of a Nordic NWFZ, but it took more than 20 years before other Nordic governments gave serious support to the idea.

In September 1980 when the Norwegian diplomat Jens Evensen suggested that Norway should take the lead in establishing a Nordic zone. Eversen's proposal sparked a grand debate among the political parties in Norway, and particularly within the Labor party. In 1982, former Norwegian Prime Minister Gro Harlem Brundtland presented a list of preconditions for supporting a Nordic zone:

1. Maintaining a low level of tension in the Nordic region was imperative.

2. It had to be based on mutual commitments and restraints, in a balanced manner.

3. The broader disarmament framework, such as the negotiations on the reduction of long range missiles, was to be given priority. The zone had to be seen as a part of the bigger picture.

4. Solutions had to be found that could be accommodated into the NATO-cooperation, and that would result in less nuclear weapons both in the east and the west.

Between 1984-85, a bipartisan commission studied the feasibility of the zone and presented its recommendations to the Norwegian Parliament. In the period from 1987 til 1991, a Nordic Senior Officials Group also discussed the possibility of the zone and in 1993, the Nordic Council recommended its establishment. But the end of the Cold War led to the mistaken belief that nuclear abolition was no longer urgent, and the idea lost momentum.

Today, however, the issue of nuclear weapons is once again at the center of the global stage. I strongly believe that the time has come for the Scandinavian countries to take a united stance on this issue. Most of the world's nations live in nuclear weapon free zones. This does not give them any real protection, since the catastrophic environmental effects of nuclear war would be global, not sparing any nation. However, by becoming members of NWFZ's, nations can state that they consider nuclear weapons to be morally unacceptable, a view that must soon become worldwide if human civilization is to survive.

By establishing a Nordic Nuclear Weapon Free Zone we in Scandinavia can express our belief that nuclear weapons are an absolute evil; that their possession does not increase anyone's security; that their continued existence is a threat to the life of every person on the planet; and that these genocidal and potentially omnicidal weapons have no place in a civilized society.

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