

## Scientists and War 1916-2016

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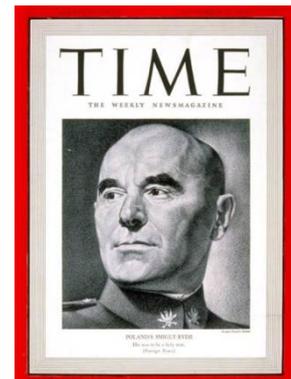
The quest for understanding and to know how things work – to find out why they are, what they are - has always been a major driving force for scientists. There are, however, other more negative external drivers – such as the pursuit for military superiority, even in times of peace. Science and engineering have unfortunately made killing easier by helping to develop new types of weapons and World War 1 saw more than its fair share of those.



The war also saw a mixture of attitudes from scientists and engineers. Many thought it their duty to help develop new weapons technologies. But there were also those who would not participate in the killing.

To understand the social pressures on scientists who spoke out against the war, we need to recognise the cultural context at that time.

Just before World War 2 an article in *Time* magazine dated 11 September 1939, entitled *Science and War*, expressed the opinion that scientists were not to blame for the way in which their discoveries were used by “men of bad will” and misapplied to “the conquest and murder of men”. This also seemed to be the attitude of many scientists in 1914, and perhaps remains so today. Some though were directly involved.



*Time Magazine Front Cover, September 11, 1939*

At the outbreak of the First World War, men with specialist scientific and technological skills were not prevented from serving at the Front – by Germany or the Allies. Although some were placed into departments of the armed forces where their skills could be used – for example

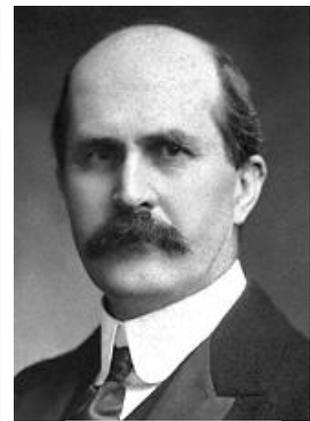
Physicists Ernest Rutherford (Professor of Physics at Manchester since 1907 and winner of the 1908 Nobel Prize in Chemistry) and William Henry Bragg (holder of the Cavendish chair of physics at Leeds since 1909) went to carry out anti-submarine work for the Admiralty.



*Ernest Rutherford*



*Listening for sounds emitted by submarines*



*William Henry Bragg*



William Lawrence Bragg

However, Bragg's son, William Lawrence, became a Second Lieutenant serving in France as technical head of an experimental Sound Ranging section - using microphones to locate enemy gun positions.

Together, the Braggs founded the science of X-ray Crystallography and were jointly awarded the Nobel Prize in Physics in 1915 for their development of this technique to study crystal structures.



At 25 years old, Lawrence remains the youngest scientific Nobel Laureate.



Walther Nernst

In Germany several scientists took commissions in the army – in particular Walther Nernst and Fritz Haber worked on the development of poison gases. Haber is given the dubious honour of introducing chemistry into the war by developing a technique for blowing chlorine gas over French and Canadian troops.

There is more to say about Franz Haber. Before the war, he and Carl Bosch from BASF invented a catalytic process to produce ammonia from hydrogen and nitrogen in the air. The Haber-Bosch process successfully produced commercial quantities of ammonia, making it possible for the first time to mass-produce nitrogen-based fertilizers.

Their work enabled greater agricultural yields which brought food to millions of starving people. A third of the world's food is now grown using fertilizers produced by this process. In 1918 Haber was awarded the Nobel Prize in Chemistry.



Fritz Haber

But, as an example of how a discovery that can benefit humanity can also help to destroy it, the Haber-Bosch process was also vital for the manufacture of nitrogen-based explosives for the German Army. Previously, explosive manufacture relied on guano, manure from seagulls that roosted along the coast of Chile. This would arrive in Germany

**The Haber-Bosch process produces 500 million tons (453 billion kilograms) of nitrogen-based fertilizer annually**

Franz Haber 1868 - 1934

by tankers crossing the Atlantic - past patrolling British warships. The Haber-Bosch process enabled Germany to become self-sufficient in the materials to make wartime explosives for shells and bullets - and was thus responsible for the death of millions.

During the war Haber worked just a bit too enthusiastically directing German research into new poison gases. He was present when chlorine gas was first released by the German military at the

Second Battle of Ypres in 1915. He was a proud, patriotic German and perhaps described the attitude to war of many scientists when he said:

*"During peace time a scientist belongs to the World, but during war time he belongs to his country"*



*Clara Immerwahr 1870 - 1915*

... which brings us to Clara Immerwahr, the German born wife of Fritz Haber. In 1898, Clara Immerwahr became the first woman in Germany to pass the difficult predoctoral examination that had been designed to raise standards in the training of chemists. In December 1900 she was awarded a doctorate in physical chemistry *magna cum laude*. She was the first woman Ph.D. at the University of Breslau. On this occasion, she took an oath ...

“... never in speech or writing to teach anything that is contrary to my beliefs. To pursue truth and to advance the dignity of science to the heights which it deserves.”

She married Haber in 1901. Her research was hindered by the stereotypes of women at that time and instead she helped her husband with his and translated his works into English - but received no credit for her part.

Clara Immerwahr came out in open opposition to Haber's, condemning this “perversion of the ideals of science” as “a sign of barbarity, corrupting the very discipline which ought to bring new insights into life.” She several times pleaded with him to cease working on gas warfare. His angry response was to accuse her in public of making statements treasonous to the Fatherland.

Shortly after Haber returned from the gas attacks in Flanders in April 1915, Clara picked up Haber's military pistol and shot herself in the chest. She died in her son's arms.

The morning after her death, Haber left home to stage the first gas attack against the Russians on the Eastern front. Her suicide was kept secret.

However, many scientists were of the opinion that science was above and separate from politics and obligations to country. One such scientist was Marie Curie.



*Marie Curie 1867-1934*

Born Maria Salomea Skłodowska in Warsaw in 1867, she earned her higher degrees in Physics and the Mathematical Sciences at the Sorbonne in Paris. There she also met and married Pierre Curie, Professor in the School of Physics and shared the 1903 Nobel Prize in Physics with him and physicist Henri Becquerel for their work on spontaneous radiation.

Following Pierre's tragic death in a road accident in 1906, she took over as Professor of General Physics, the first time a woman had held that position and 5 years later she was awarded the Nobel Prize in Chemistry in recognition of her work in radioactivity.



*First Solvay Conference (1911), Curie (seated, second from right) confers with Henri Poincaré; standing, fourth from right, is Rutherford; second from right, Einstein; far right, Paul Langevin*

Promptly after the start of World War 1, Marie Curie attempted to donate her gold Nobel Prize medals to the war effort but the French National Bank refused to accept them, so instead she used her Nobel Prize money to purchase war bonds. At the outbreak of war, Curie became director of the Red Cross Radiology Service and established 20 mobile radiography units and 200 radiological units at field centres close to the front lines to assist surgeons.

After the war, in August 1922, she became a member of the “International Commission for Intellectual Cooperation” - an advisory organization for the League of Nations which aimed to promote international cultural/intellectual exchange between scientists, researchers, teachers, artists and other intellectuals.

At the time of World War 1 many scientists had grown up in an age when there was a strong international feel about science. Many had studied and worked with colleagues in the ‘enemy’ country. Despite the war, letters continued to pass between scientists on different sides, sharing research results and enquiring after colleagues.

For example, in 1915 Rutherford was writing to his former assistant Hans Geiger who was serving in the German Army. There was a belief that the interests of science transcended the war which



*Hans Geiger was Rutherford’s main partner in alpha-ray research from 1907 to 1913. Together they developed several ways to detect alpha particles and proved they are doubly-ionized Helium nuclei.*

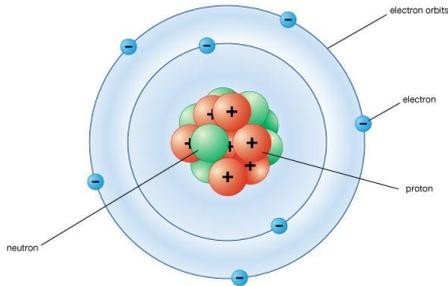
was merely a temporary and regrettable situation.

However, one British scientist, who was keen to go to war, was Henry Moseley.

An outstandingly skilled experimental physicist, in 1913 Moseley had shown that each element can be uniquely identified by an ‘atomic number’ representing the number of protons, or positively charged particles, in its nucleus. This was the first experimental evidence in favour of Bohr’s model of the atom.



*Henry Moseley 1887-1915, realized that an element is defined by its number of protons. If an element has one proton it must be hydrogen; two protons must be helium, three protons must be lithium, etc, etc.*



**Model of an atom of Nitrogen - 7 protons, 7 neutrons, 7 electrons**

Moseley was also able to predict the existence of four new chemical elements which were discovered later [technetium, promethium, hafnium and rhenium].

At the outbreak of the war Moseley enlisted as a volunteer in the Royal Engineers and took part in the invasion of Gallipoli in April 1915 as a telecommunications officer.

He was shot and killed at the age of 27, while telephoning a military order on 10th August.

Consequently, after much lobbying by Ernest Rutherford, the British government placed a ban on scientists of repute serving in front-line roles.

[No Nobel Prizes were awarded in 1916 for physics or chemistry but there is a strong consensus that, had he survived, Henry Moseley would have received one of these awards.]



**Germany's invasion of France through Belgium brought world criticism of Germany as a brutal aggressor nation.**

### AN DIE KULTURWELT!

Wir als Vertreter deutscher Wissenschaft und Kunst erheben vor der gesamten Kulturwelt Protest gegen die Lügen und Verleumdungen, mit denen unsere Feinde Deutschlands reine Sache in dem ihm aufgezwungenen schweren Daseinskampfe zu beschmutzen trachten. Der ehren Mund der Ereignisse hat die Ausbreitung erleichteter deutscher Niederlagen widerlegt. Um so eifriger arbeitet man jetzt mit Entstellungen und Verdächtigungen. Gegen sie erheben wir laut unsere Stimme. Sie soll die Verkünderin der Wahrheit sein.

**Es ist nicht wahr,** daß Deutschland diesen Krieg verschuldet hat. Weder das Volk hat ihn gewollt noch die Regierung noch der Kaiser. Von deutscher Seite ist das Äußerste gesehen, ihn abzuwenden. Dafür liegen der Welt die urkundlichen Beweise vor. Oft genug hat Wilhelm II. in den 26 Jahren seiner Regierung sich als Schutzherr des Weltfriedens erwiesen; oft genug haben selbst unsere Gegner dies anerkannt. Ja, dieser nimmliche Kaiser, den sie jetzt einen Atilla zu nennen wagen, ist jahrzehntlang wegen seiner unerschütterlichen Friedensliebe von ihnen verspottet worden. Erst als eine schon lange an den Grenzen lauernde Übermacht von drei Seiten über unser Volk herfiel, hat es sich erheben wie ein Mann.

**Es ist nicht wahr,** daß wir freventlich die Neutralität Belgiens verletzt haben. Nachweislich waren Frankreich und England zu ihrer Verletzung entschlossen. Nachweislich war Belgien damit einverstanden. Selbstvernichtung wäre es gewesen, ihnen nicht zuzukommen.

**Es ist nicht wahr,** daß eines einzigen belgischen Bürgers Leben und Eigentum von unseren Soldaten angetastet worden ist, ohne daß die bitterste Notwehr es gebot. Denn wieder und immer wieder, allen Mahnungen zum Trotz, hat die Bevölkerung sie aus dem Hinterland beschossen, Verwundete verstümmelt, Ärzte bei der Ausübung ihres Samariterwerkes ermordet. Man kann nicht niedertreulicher fälschen, als wenn man die Verbrechen dieser Meuchelmörder verschweigt, um die gerechte Strafe, die sie erlitten haben, den Deutschen zum Verbrechen zu machen.

**Manifesto of the 93  
October 4, 1914**

There had been considerable international criticism of Germany for attacking Belgium, a neutral country. In response, some two months after the outbreak of the war, the so-called "Manifesto of the Ninety-Three" was published in Germany.

93 signatories, including scientists and many well-known artists and writers, attempted to justify the German invasion and glorify the war as a struggle for culture. It postulated German moral and cultural superiority.

The manifesto first appeared in German (under the title "Appeal to the Civilized World") and then in ten translations, sparking furious responses from scientists in England and France, who published fierce denunciations of the "German barbarians."

### Manifesto of 93 Signatories (*Nobel Prize Winners*)

**Adolf von Baeyer**, Peter Behrens, **Emil Adolf von Behring**, Wilhelm von Bode, Alois Brandl, Lujo Brentano, Justus Brinckmann, Johannes Conrad, Franz von Defregger, Richard Dehmel, Adolf Deissmann, Wilhelm Dörfeld, Friedrich von Duhn, **Paul Ehrlich**, Albert Ehrhard, Karl Engler, Gerhart Esser, **Rudolf Christoph Eucken**, Herbert Eulenberg, Henrich Finke, **Hermann Emil Fischer**, Wilhelm Foerster, Ludwig Fulda, Eduard von Gebhardt, Jan Jakob Maria de Groot, **Fritz Haber**, Ernst Haeckel, Max Halbe, Adolf von Harnack, Carl Hauptmann, **Gerhart Hauptmann**, Gustav Hellmann, Wilhelm Herrmann, Andreas Heusler, Adolf von Hildebrand, Ludwig Hoffmann, Engelbert Humperdinck, Leopold Graf von Kalckreuth, Arthur Kampf, Friedrich August von Kaulbach, Theodor Kipp, Felix Klein, Max Klinger, Alois Knoepfler, Anton Koch, Paul Laband, Karl Lamprecht, **Philipp Lenard**, Maximilian Lenz, Max Liebermann, Franz von Liszt, Ludwig Manzel, Joseph Mausbach, Georg von Mayr, Sebastian Merkle, Eduard Meyer, Heinrich Morf, Friedrich Naumann, Albert Neisser, **Walther Hermann Nernst**, **Wilhelm Ostwald**, Bruno Paul, **Max Planck**, Albert Plohn, Georg Reicke, Max Reinhardt, Alois Riehl, Carl Robert, **Wilhelm Roentgen**, Max Rubner, Fritz Schaper, Adolf von Schlatter, August Schmidlin, Gustav von Schmoller, Reinhold Seeberg, Martin Spahn, Franz von Stuck, Hermann Sudermann, Hans Thoma, Wilhelm Trübner, Karl Vollmöller, Richard Voss, Karl Vossler, Siegfried Wagner, Wilhelm Waldeyer, August von Wassermann, Felix Weingartner, Theodor Wiegand, **Wilhelm Wien**, Ulrich von Wilamowitz-Moellendorff, **Richard Willstätter**, Wilhelm Windelband, Wilhelm Wundt

Among the signatories of the “*Appeal to the Civilized World*” were many outstanding scientists such as Wilhelm Röntgen and Max Planck (although he later withdrew his signature). 14 of them were Nobel Prize winners (shown in bold italics).

One of the 93 who soon regretted having signed it was Wilhelm Foerster, professor of astronomy at the University of Berlin, previously director of the Berlin Observatory. He had also helped found the German Society for Ethical Culture (in which Albert Einstein also participated) and was a member of the German Peace Society [the *Deutsche Friedensgesellschaft*]. Foerster helped produce a counter document - a “*Manifesto to the Europeans*.”



Wilhelm Julius Foerster  
1832-1921

This ‘pacifist’ *Manifesto* argued that:

#### Manifesto to the Europeans October, 1914

"it seems not only *good*, but rather bitterly *necessary* that *educated men of all nations* marshal their influence such that — whatever the still uncertain end of the war may be — the *terms of peace shall not become the wellspring of future wars*. The evident fact that through this war all European relational conditions slipped into an *unstable and plasticized state* should rather be used to create an organic European whole."



The Wilhelm – Foerster Observatory  
in Berlin - one of the largest public  
observatories

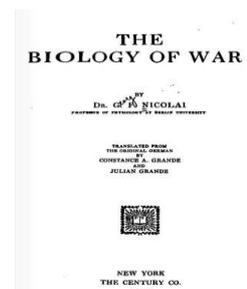
However, only physicist Albert Einstein and philosopher Otto Buek added their signatures and it was not published in German.



Georg Friedrich Nicolai  
1874-1964

In 1918, the author of the pacifist manifesto, Georg Friedrich Nicolai, also published *The Biology of War*, an indictment of warfare which was translated into several languages. As a result, he was demoted and sent from Berlin University to a remote institute in West Prussia.

In the 1930s he wrote a Natural History of National



Nicolai's indictment of warfare  
was published during the first  
World War and translated into  
several languages.

Socialist Movement, and of Nationalism in general, in which he denounced nationalism as:

*“one of the greatest, possibly the greatest danger to the further development of the human race”.*

He died on 8 October 1964 in Santiago de Chile.



Albert Einstein 1879-1955

Albert Einstein also signed the pacifist manifesto. He had become recognised as a leading scientist at the age of 26, following the publication of four groundbreaking physics papers, including one on Relativity. After several university posts in Prague and Zurich he returned to Germany in 1914 as director of the Kaiser Wilhelm Institute for Physics and professor at the Humboldt University of Berlin.

**“The world will not be destroyed by those who do evil but by those who sit by and do nothing”**

*Einstein's tribute to Pablo Casals (30 March 1953)*

In August Germany declared war on Russia and France - two weeks later Einstein wrote:

*“It is in such times that we see to what a miserable species of cattle we belong.”*

As an intellectual and a pacifist, he felt very much alone as he witnessed the intellectual mobilization of his colleagues. Throughout the First World War Einstein supported anti-war movements in whatever ways he could. In 1919 his theories about the relation of time and space and the nature of gravity was dramatically confirmed by an English physicist – Sir Arthur Eddington.

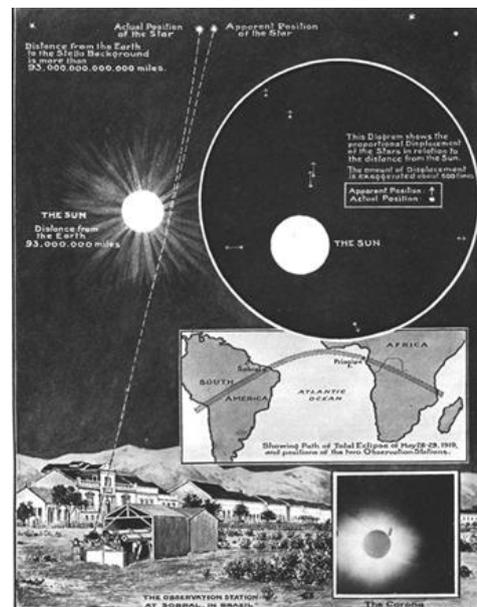


Sir Arthur Eddington 1882-1944

As a Quaker, Eddington was granted an alternative to military service. He was among the very few who understood Einstein's ideas and was keen to work to endorse them. However, the British government did not want to be seen to validate a German claim to a huge

scientific achievement. So Eddington's exemption to the draft was granted on condition that he conducted his own proposal test of the theory.

According to Einstein, light coming from a distant star should bend as it went past the sun and Eddington proposed to test this from observations off the coast of



1919 - Arthur Eddington led an expedition to Principe Island in Africa to record the positions of stars around the Sun during a solar eclipse

Africa of the 1919 solar eclipse. The exercise required an expedition, meticulous data collection and precise calculation - but the results made world headline news and Einstein an international celebrity.

Travelling through northern France in 1922, Einstein was horrified by the still-ravaged battlefields of the First World War.

*“War is a terrible thing, and must be abolished at all costs”*

he repeated over again.

In 1928 Einstein began to make public his support for the ‘*absolute refusal of military service*’. With other international pacifists, he signed a manifesto against military conscription and was elected to the board of the pacifist German League for Human Rights. *“I am not only a pacifist but a militant pacifist. Nothing will end war unless the people themselves refuse to go to war”* he said.

He continued his scientific work and his international work for peace from the same desk.

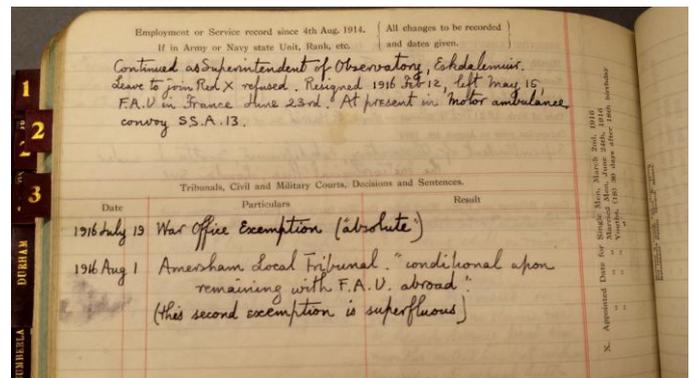
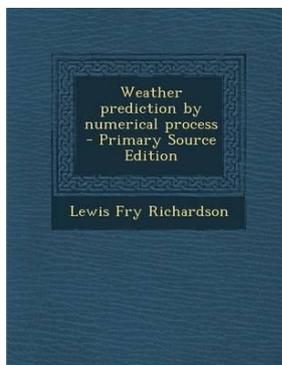


Lewis Fry Richardson 1881-1953

Lewis Fry Richardson was another Quaker scientist/mathematician. He had attended Bootham School in York and graduated from King’s College, Cambridge with a first class degree in 1903. He joined the Met Office and became superintendent of Eskdalemuir Observatory from 1909-1912.

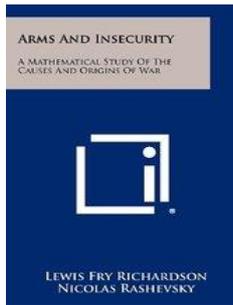
During World War I he was exempted from military service as a conscientious objector, although this also subsequently disqualified him from taking up any academic post. From 1916 to 1919 he worked for the Friends’ Ambulance Unit.

After the war, he rejoined the Met Office where he proposed a scheme for weather forecasting by the solution of differential equations, a method still used today although then computers were not available and people had to solve them manually.



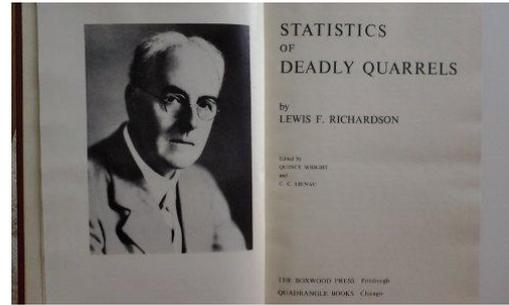
**Being an ardent pacifist exempted him from military service during World War as a conscientious objector, but subsequently disqualified him from having any academic post**

But he was forced to resign in 1920 when the Met Office became part of the Air Ministry and, on discovering that his work was of value to chemical weapons designers, he also destroyed all his unpublished papers. Instead he applied his mathematical skills to the issue of peace.



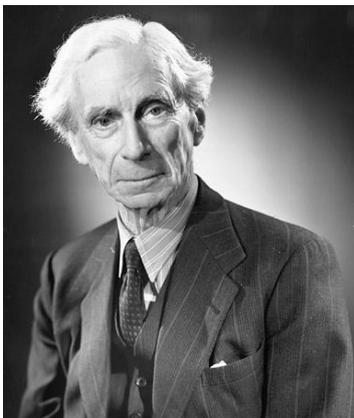
*First published 1949*

In *Arms and Insecurity* Richardson studied international interactions and war using similar methods to those he had developed for weather forecasting.



*First published 1960*

And in *Statistics of Deadly Quarrels* he analysed data on virtually every war from 1815 to 1945 but found no tendency for their increase or decrease over time, nor any countries responsible for a disproportionate number of wars.



*Bertrand Russell 1872-1970*

Another notable mathematician, Bertrand Russell, was born into an influential and liberal British aristocratic family. Already established as a world-famous intellectual and mathematician, he was one of the few people to engage in active pacifist activities during World War 1. In 1916, he was prosecuted and fined for publishing (in defence of a conscientious objector):

**“War does not determine who is right, only who is left”**

*Attributed to Bertrand Russell*

*“statements likely to prejudice the recruiting and discipline of His Majesty's forces”*

He was systematically dismissed from Trinity College.

Russell played a significant role in the *Leeds Convention* in June 1917, when over a thousand anti-war socialists gathered advocating a peace settlement. A week later he joined the Independent Labour Party and the following month he published three consecutive texts for *The Tribunal*, the No Conscription Fellowship (NCF) newspaper, which he co-edited at the time. He put the case for converting pacifists to the revolutionary movement to abolish capitalist and State domination and rebuild society on a new basis.

In 1918 he was sent to Brixton Prison for 6 months for publicly lecturing against the US entering the war and while there he wrote an *Introduction to Mathematical Philosophy*.

Later, he campaigned against Adolf Hitler; criticised Stalinist totalitarianism and attacked the involvement of the US in the Vietnam War.

He was awarded the Nobel Prize in Literature in 1950.

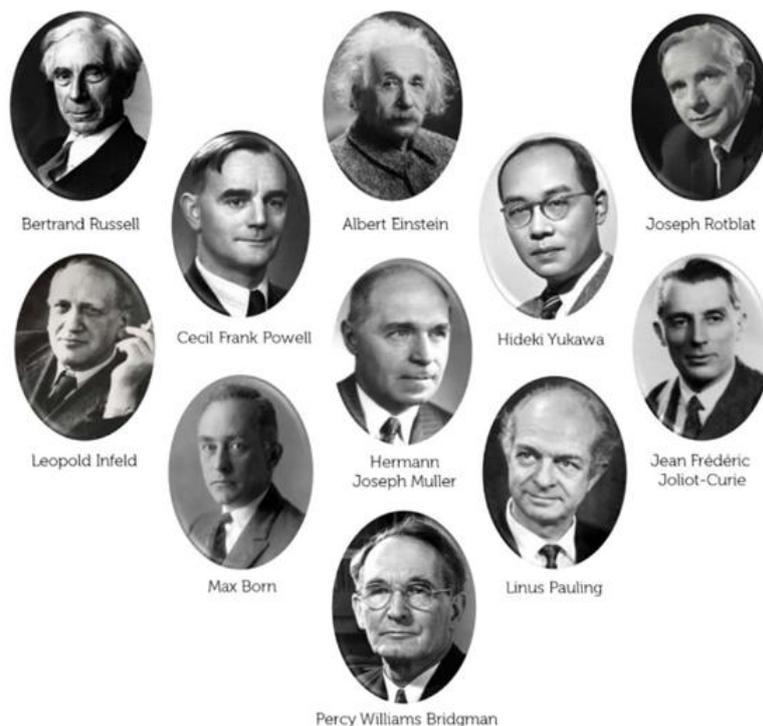
*“in recognition of his varied and significant writings in which he champions humanitarian ideals and freedom of thought”*

In December 1954 Russell delivered a BBC radio broadcast entitled *Man's Peril*, drawing on the testimonies of scientists and military strategists. It painted a grim picture of a possible devastating nuclear war - but he remained optimistic that it could be averted. The positive response he received pushed him back into anti-war protest and in July 1955, in the midst of the Cold War, he issued a statement signed by a number of scientists ...



*Bertrand Russell reading the proclamation of the Russell-Einstein Manifesto in Caxton Hall, London, on 9 July 1955.*

... calling for world leaders to seek peaceful resolutions to international conflict. Albert Einstein, had signed it just days before his death 3 months previously and it became known as the *Russell-Einstein Manifesto*.



11 well known scientists were signatories and afterwards philanthropist Cyrus S. Eaton offered to sponsor a conference called for in the manifesto. It was held in Pugwash, Nova Scotia in July 1957 and was the first *Pugwash Conference on Science and World Affairs*.

Russell was also an outspoken proponent of nuclear disarmament and founder member of the Campaign for Nuclear Disarmament (CND) launched in 1958. His views on nuclear weapons were unusual however – prior to 1949 he advocated a preventive nuclear strike while the US was the only country to possess them but strongly opposed them all once the Soviet Union had them.

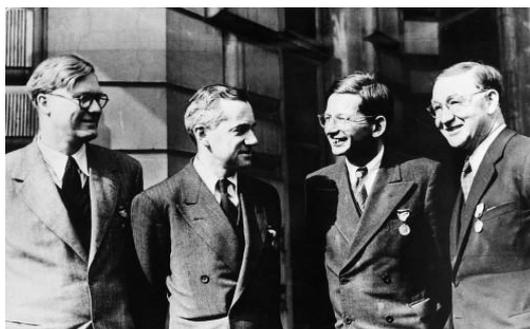
He became a strong advocate of a mass civil disobedience campaign against nuclear weapons and resigned from the presidency of CND to help form the Committee of 100, which was launched in London in October 1960. I am pleased to say that the two groups have come together again!



At the start of World War 2, in 1939, the Hungarian physicist Leó Szilárd, saw the military potential in the discovery of nuclear fission by Otto Hahn in Germany and was convinced that it was vital for the US to develop an atomic bomb before the Nazis.

He persuaded Albert Einstein to sign a letter to President Roosevelt, warning that Germany might be developing an atomic bomb. The letter led to the Manhattan Project in a race to build nuclear weapons first.

The most able scientists in the US and Europe were recruited to work under the control of the US Army and the scientific direction of the brilliant physicist J. Robert Oppenheimer. Their work was to be carried out in utter secrecy in Los Alamos, a specially made town in the desert of New Mexico.



*Some of the British scientists at Los Alamos: William Penney, Otto Frisch, Rudolf Peierls and John Cockroft*



*Brig. Gen. Leslie R. Groves (left) Project Director and J. Robert Oppenheimer (right) Director of the Laboratory*



*Lise Meitner 1878-1968*

Some scientists did refuse to take part, for example, Austrian physicist Lise Meitner, a key figure in the discovery of nuclear fission who worked with Otto Frisch in 1939 and helped to establish the possibility that it could be used as a weapon. She turned down the invitation declaring

*"I will have nothing to do with a bomb."*

She later echoed a comment often made by scientists then and now:

*"You must not blame us scientists for the use which war technicians have put our discoveries."*

However, most of the scientists approached did agree to participate and the difficulty of finding a solution and the intellectual challenges raised became the top priority for those involved. The possible repercussions did not appear to have been considered by many.

On the defeat of Hitler it was discovered that there had not been a significant programme to develop a nuclear weapon in Germany. However, the war with Japan was ongoing and US military and political leaders continued with the project - and the cities of

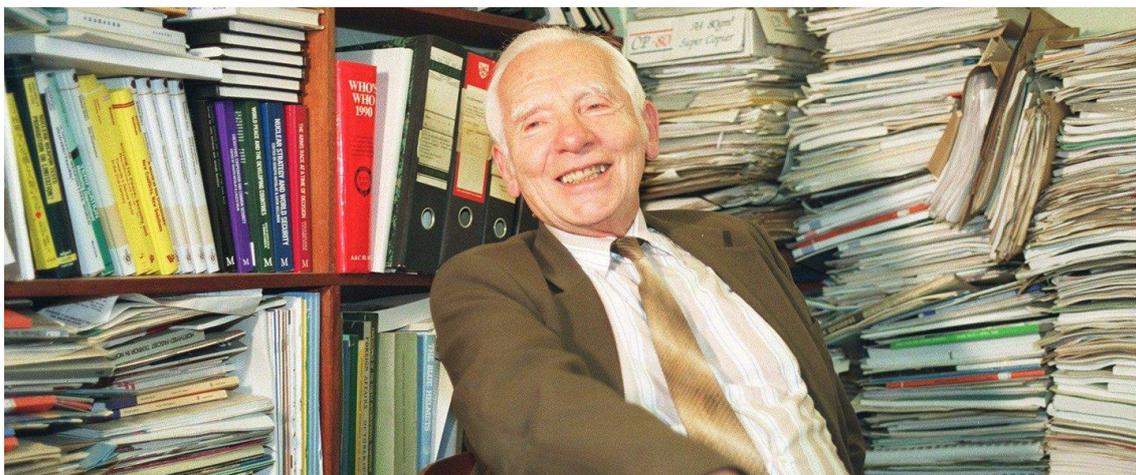


Hiroshima (above left) and Nagasaki (above right) were destroyed. Hundreds of thousands of people were killed or suffered severe and long lasting injuries, and a nuclear arms race ensued accompanied by the threat of global annihilation that still exists today.

There was one person who did not stay on however.

Joseph Rotblat withdrew from the project in 1943 when it became clear to him that Germany would not manage to make an atomic bomb before the war was over. He had taken up research in Britain in 1939 and his work on splitting the atom led him to Los Alamos.

After the war, Rotblat became a British citizen and devoted himself to the medical applications of nuclear physics.



*Joseph Rotblat 1908-2005*

In 1955 he signed the Russell-Einstein Manifesto and helped to found the annual Pugwash Conferences, acting as secretary-general from 1957–73 and as president from 1988.

He received the Nobel Peace Prize, along with the Conferences, in 1995 and died in 2005, aged 93.

Another signatory of the Russell-Einstein Manifesto was Linus Pauling.



*Linus Pauling 1901-1994*



*Linus & Ava Helen Pauling, Los Angeles Peace March -1960*

He remains the only person ever to receive two unshared Nobel Prizes — for Chemistry in 1954 and for Peace in 1962. The prize for Chemistry was made in recognition of his work on the nature of the chemical bond and the structure of molecules, proteins and crystals.

In the late 1950s and early 1960s he became a significant campaigner against atmospheric nuclear tests, using scientific data and statistics to show that radioactive fallout increased the incidence of cancer and genetic disorders, including birth defects.

Pauling's six-year campaign included a petition to the United Nations, signed by over 11,000 scientists. Finally, a treaty was signed by the three nuclear powers — the US, Britain, and the USSR.

On October 10, 1963, the day the limited test ban came into effect, it was announced that he had been awarded the Nobel Peace Prize.



*Kathleen Lonsdale 1903 - 1971*

Kathleen Lonsdale was another British crystallographer who attained several firsts for a woman scientist, including one of the first two women elected a Fellow of the Royal Society (FRS) in 1945 (along with Marjory Stephenson), first woman tenured professor at University College London, first woman president of the International Union of Crystallography, and first woman president of the British Association for the Advancement of Science.

She obtained her physics degree, aged 19, in 1922 obtaining the highest marks of any student for ten years and was invited to join William Henry Bragg's crystallography research team at the Royal Institution in 1924.

She married engineer Thomas Lonsdale in 1927 and moved with him to Leeds where she worked in the Chemistry Department at the University of Leeds.

During the early 1930s, she cared for her small children nearly full-time and became a Quaker in 1935, simultaneously with her husband. Already committed pacifists, both were attracted to Quakerism for this reason.

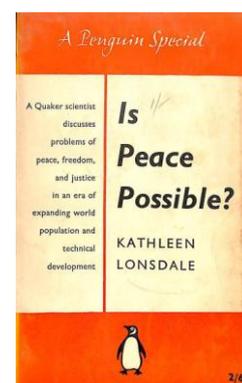
She was a Sponsor of the Peace Pledge Union and served a month in Holloway prison during the Second World War because she refused to register for civil defense duties, or pay a fine for refusing to register. After the war she became an anti-nuclear campaigner, was involved in the Pugwash Conferences and served as President of the British section of the Women's International League for Peace and Freedom. She also took part in a Quaker delegation to the Soviet Union in 1951.

In 1953 she delivered the keynote speech at the annual meeting of the British Quakers, entitled "*Removing the Causes of War*". As a Christian pacifist, she was appointed the first secretary of Churches' Council of Healing by the Archbishop of Canterbury, William Temple.

In 1956 she wrote, *Is Peace Possible?*, in which she explored the relationship between world peace and world population needs. She felt that the causes of war should be removed by promoting just relationships among nations, even if it meant addressing global inequalities in wealth and resource distribution.

The role of science and the scientist in war is increasingly important. We will not survive a war fought with nuclear weapons. The results would be far worse and more widespread than even the devastation of World War 1, illustrated in Paul Nash's famous painting. We need instead to aim to be the new dawn rising over the mountains.

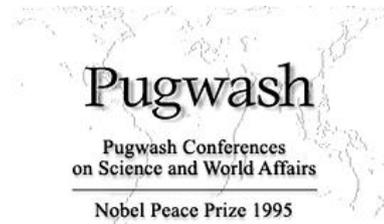
The world is facing huge problems - anthropogenic climate change and nuclear proliferation are enormous challenges and the actions and policies we take during the next few years could decide the survival of the planet. Scientists and engineers can help tackle these problems or they can aggravate them.





*Sunrise, Inverness Copse (1917), by Paul Nash, collection of the Imperial War Museum, London*

National and International organisations do exist to help scientists uphold a moral stance on important issues. Apart from the International Pugwash group.



The Global Union of Scientists for Peace arose from the ashes of the failed Nuclear Non-Proliferation Treaty (NPT) Review Conference in 2005.

The “International Network of Engineers and Scientists for Global Responsibility” (INES) was founded in 1991 in Berlin at the international congress “Challenges - Science and Peace in a Rapidly Changing Environment” and it has become a network of over 160 organisations and individual members.



the US has a “Union of Concerned Scientists” founded in 1969 by scientists and students at the Massachusetts Institute of Technology, appalled at how the U.S. government was misusing science.

The UK “Scientists for Global Responsibility” (SGR) have made a significant contribution to debate and discussion on the ethical use of science and the militarisation of universities. In July 2016, during the campaign to stop the replacement of the UK Trident nuclear



weapons system, a number of prominent scientists, including Stephen Hawking and Peter Higgs, signed the SGR letter urging MPs to vote against renewal.

The scientist has a special responsibility to assess carefully the consequences of his/her research, and to make them public. The way we develop and use technology is a clear indicator of our value system.

The problems of climate change and nuclear annihilation are consequences of thoughtless and selfish technological development. But in response we see those in control focusing on containment - protecting their interests, monitoring and controlling social unrest – at a time when we need global cooperation on an unprecedented scale. We urgently need to transform our war based societies, and accompanying technologies, into ones that are far removed from the situation in Europe 100 years ago.