Leo Szilard will go down in history as the scientist who not only hastened the process of the atomic bomb, but realizing its immensely destructive potential also fought hard to prevent the weapon from being unleashed to annihilate humans.

No activity in modern science can be attributed to a single person, least of all the invention of the atomic weapon, which was a mammoth multidisciplinary effort. Actually it was not a single discovery but a culmination of a chain of discoveries in atomic physics, mixed with a fair dose of technological inputs. But the joining of dots of various results was guided by the political situation prevailing during that period.

So, even if no single person can be credited for the technical content of the nuclear weapon, there were indeed a couple of persons who were instrumental in triggering the action for the discovery and giving it the direction that it eventually took.

These two persons were Albert Einstein and a lesser-known physicist Leo Szilard, without whose initiative the atom bomb might not have been invented when it was. Einstein, not for the famous mass-energy relationship, $E = mc^2$, which
is the basis of unfathomable energy of the atom, but because of the letter he wrote in 1939 to President Roosevelt of America urging him to start work on chain reaction in uranium (see Science Reporter, February 2012, pp 42). This letter indeed is the most important document in the history of science as it initiated the American action in the World War, which was being fought in Europe till then. In fact that letter is considered to have changed life on the Earth forever.

But Einstein’s was not the soul behind that letter. His was only the signature. It was Leo Szilard who thought about writing such a letter to the US President and thought of Einstein as the most influential person whose signature would be able to move the massive machinery of the US government. Szilard convinced the pacifist Einstein to put his signature on the letter that he had prepared, so that the work on uranium could start and results obtained before Germany could get to them.

Thinking Differently
Szilard was a scientist with a different mental orientation. Most scientists concern themselves with the science per se, but he had seen so much of political influence on his life that he had two tracks in his mind, those of science and politics; peculiarly, his science track had continuous feed from the political track.

Born in Hungary in 1898, he witnessed Europe in turmoil by the time he entered college. As the First World War approached he had to devote a year of compulsory military service mid way through the University education. In 1919, a Bolshevik dictator Bela Kun came to power in Hungary under the wave of the Leninist revolution. Jews being an intellectual community had helped Kun.

However, within four months his government caved in and another dictator, Admiral Horthy, a reactionary, took over. The regime change compounded Szilard’s bad luck; he and his brother were refused readmission into the Budapest Technical University as reprisals started against the Jews. This was notwithstanding his conversion to ‘Calvinist Christian’ faith long ago. He thus had to migrate to Berlin, Germany to finish his studies.

Till then, in 1922, Germany was not yet a hotbed of racial discrimination. He obtained his Ph.D. and became an assistant to the famous crystallographer Von Laue. But Hitler rose to power in 1933 and the backlash against the Jewish population began. Szilard had to migrate further to Austria and then again to England, when Austria was run over by Hitler!

Chain Reaction – Imaginary and the Real
Meanwhile, modern physics was going through an eventful period. In 1932, with the discovery of neutron by the British physicist Chadwick, the structure of atom proposed by Lord Rutherford in 1911 became complete. This particle turned out to be a potent tool for exploring the atom and its nucleus further. Stable atoms of many elements became radioactive when a neutron was fired towards their nuclei. They emitted either alpha or beta particles. In one case it even emitted two neutrons.

It was in January 1939 that Lise Meitner and Otto Frisch explained the experimental results of Hahn and Strassman by naming the new phenomenon as ‘fission’ and showing that there was an energy release during the

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process (see SR, December 2010). By this time Szilard had moved to England and then to the USA. And Hitler had entered Austria, Poland, Bolivia and Moravia. He was close to France and the Second World War was nearly declared.

Szilard had an intuition. He already knew about Chain Reaction. If the uranium atom gave out two neutrons while breaking, then the neutrons could continue the process of breaking uranium atoms. This would give billions of fissions as a result of these chain reactions – this time the ‘real’ chain reaction. He knew this amounted to abundant release of energy.

At some other point of time in history, scientists would have been thrilled to know about such abundance of energy; but not in 1939, particularly because the news of fission had come from Germany! Most of them thought that the ruthless Nazis would produce the bomb from uranium. For Szilard, every thing now depended upon whether the fission process had some spare neutrons associated with it or not. He wished there were none.

Help From Einstein

Szilard contacted all the labs working on fission physics, requesting them NOT to publish any result on this aspect, at least till the War was over. That was not the spirit of science, many told him. He himself knew that. But such was the need of the hour, he argued. Particularly the French team of Joliot Curie was not in favour of scientific censorship. They published their results about the “Liberation of neutrons in the nuclear explosion of Uranium” in the 18th March 1939 issue of the journal Nature.

Thereafter, Enrico Fermi could not be contained; he wrote in the 15th April issue of the Physical Review. To add to Szilard’s worry, Germany had taken over Czechoslovakia in March 1939. It was known for good uranium reserves. To add to the fears, the Germans also banned export of uranium from the Czech mines! Szilard suspected that Hitler had taken Czechoslovakia exactly for this material! He had literally sleepless nights from such contrived thoughts. Such was his obsession that he took a personal loan of $2000 to work on chain reaction.

But where was the uranium for him to work on? Szilard thought of Einstein to obtain uranium. The latter knew the Belgian royal family and could help get uranium from mines in Belgian Congo. Einstein’s stature could also be useful in convincing the US government to be serious about uranium-related research. He took his fellow Hungarian physicist Wigner along and drove to Peconic in Long Island where Einstein was resting. He was not in touch with the developments in atomic physics.

When Wigner and Szilard explained to him the implications of his own equation $E = mc^2$, the great scientist remarked in German, “Daran habe ich gar nicht gedacht” – I never thought of that at all! He agreed to lend his signature if it could help contain the Nazis. A letter to President Roosevelt was drafted on 2nd August 1939 and another to the Belgian ambassador to US for uranium. The scientists wrote in these letters that Germany appeared to be aware of the importance of uranium.

Over 1,20,000 in Hiroshima and 60,000 in Nagasaki perished, half of them in the first 24 hours. Equally large numbers suffered due to radiation burns.
This effort got Szilard a grant of $6000 from the US Government to work on chain reaction. He took along one Zinn as his colleague. Nobel laureate Fermi and Anderson wanted to work on this anyway. With the patent of chain reaction being with Szilard, he had to be a collaborator.

A clumsy pile using graphite, uranium and uranium dioxide was erected in the backyard of the Chicago University in a corner of a football field. Hard work and good physics helped them achieve a self-sustaining chain reaction in the evening of 2nd December 1942. This was a great day for modern physics. All the theories and hypotheses about the structure of the invisible atom were proved in the visible form here. Mankind had now found a new form of energy, which could sustain him for ages.

But the irony was that most of the players on the scientific stage, including Szilard, missed this simple and important message. Invariably, each one of them saw this success as an indication that uranium could sustain a chain reaction required to build a bomb! Such is the power of the conditioning of the mind.

Achievements in Quick Succession
By this time America had already been dragged into the War because of the Japanese attack on Pearl Harbour and so the Government’s commitment to the project had deepened. Manhattan Project, as the project to build the ‘Super Bomb’ was called, progressed at an inconceivable speed. By then many more immigrant scientists from Europe had reached USA and each one had a tale to tell.

There was a common enemy in Hitler, though they did not articulate as clearly as Szilard would do. The result of this ensemble was that the project progressed at an incredible pace. They built plants to enrich uranium and soon a bomb was ready. Parallelly they built reactors to produce plutonium, reprocessing plants to separate plutonium from used fuel, and developed a design for an implosion type weapon and tested it. All these were done in just 30 months. Today even building a reactor takes five to eight years.
And look at the scale-up factors: to build reactors of a few megawatts power they had experience of only 200 watts pile of Fermi. Plutonium plants to get kilograms of material were backed by extraction experience of just half a milligram of plutonium! As Henry Smith has said, no one in the right frame of his mind would think of such a magnification of scale in peace time. In the matter of speed the project will go down in history, not only of science but of any human endeavour.

Around February 1945, when Germany had started retreating, intelligence reports confirmed that German scientists were not making any bomb. It was like an anti-climax for all the scientists working for the project, because the first ever nuclear bombs were nearly ready in the US by then.

Keeper of every one’s conscience, Szilard once more got into action, as if doing penance for his past sins. He drafted a letter to the President, and once again thought of Einstein to introduce him, as he had done six years ago! Once more Einstein agreed to lend his signature if it was for any good. It was 25th March 1945. In the memorandum that accompanied the letter of introduction by Einstein, Szilard talked about the danger of ‘preventive wars’, which eventually demonstrated that they had a weapon of this nature. He talked about “the continuous danger of annihilation for all cities” and need for USA to take responsibility in its prevention “by virtue of her lead in the field of atomic power”. The message was indeed prophetic.

Incidentally the first bomb was already tested a day before he wrote the petition, on 16th July, in the desert of New Mexico. The transcripts later released clearly show that Germany never was close to making a bomb. But this knowledge was now redundant. Everyone in the Laboratories knew that the address on the bomb would now change to that of Japan. Having been made, the nuclear weapon had to be tested!

Szilard then made his last attempt. He again prepared a petition for the President (now it was Harry Truman) to be signed by all the scientists, explaining why the bomb should not be used. It said that a bitter arms race would begin between USA and USSR if the former demonstrated that they had a weapon of this nature. He talked about “the continuous danger of annihilation for all cities” and need for USA to take responsibility in its prevention “by virtue of her lead in the field of atomic power”. The message was indeed prophetic.

A month later, in May 1945, Germany surrendered. Some German scientists, including Hahn and Heisenberg, were detained from German labs and put under house arrest in England. Their rooms were bugged with microphones. The transcripts later released clearly show that Germany never was close to making a bomb. But this knowledge was now redundant. Everyone in the Laboratories knew that the address on the bomb would now change to that of Japan. Having been made, the nuclear weapon had to be tested!

Fermi and Szilard

Though these two worked together for the Chicago Pile, they were most unlike each other. Fermi had a natural Italian wit whereas Szilard rarely even smiled. He himself once said, “Fermi does not know that some people like me live in two worlds simultaneously – one scientific quest and other in which we are fighting what should not happen.” Fermi was a hard worker and Szilard was laid back and would rather get work done by others. Szilard also said, “If the nation has to be grateful to us, it does so for (our) having stuck out together, as long as it was necessary.”

The authorities of the Manhattan Project treated both as the ‘enemy aliens’ because they came from countries, which were the axis powers against which allied forces were fighting. Szilard came from Hungary and had a German accent, whereas Fermi had come from Italy. Often they needed special permission to even fly for work. This was despite the fact that they were doing the most important and secret work for the USA. This is how the militarys work.