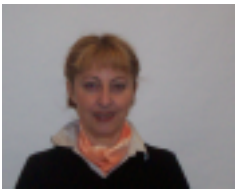


"I grew up with the belief that the truth is simple, one must only find it"

Edward Teller



By: *Eniko Madarassy*

Edward Teller died on September 9th, 2003 when he was 95. He was one of the great physicists of the 20th century. He dedicated his life to science, education and national security in such a controversial century.

“Dr. Teller lived a spectacular life on the scale of legend.” (Bruce Goodwin, Associate Director, Lawrence Livermore National Laboratory) “He was a passionate advocate for science and the development of L.L.N.L.. He devoted his life to preserving freedom, pursuing new knowledge and passing along his passion for science and engineering education to students of all ages.” (Michael Anastasio, Director, Lawrence Livermore National Laboratory)

“Edward was a treasure at the Hoover Institution. Throughout his time at Hoover, he was a brilliant, interesting, though-provoking, collegial, and incredible institutional citizen.”(John Raisian, Director, Hoover Institution) “Another little-known side of Edward was his charm - especially with women and children....” (Sig Hecker, former Director, Los Alamos National Laboratory)

Teller was a fellow of the American Physical Society and the American Nuclear Society,

moreover a member of the National Academy of Sciences, the American Academy of Science and the Advisory Board of the Federal Emergency Management Agency. In addition, he was on the White House Science Council.

Teller was an associate of the Scientific Advisory Board of the U.S. Air Force and was chairman of the first Nuclear Reaction Safeguard Committee. From 1956 to 1958, he worked as a member of the General Advisory Committee of the U.S. Atomic Energy Commission.

Teller received numerous honours, for example: the Presidential Medal of Freedom, the Albert Einstein Award, the Enrico Fermi Award, the National Medal of Science, the Presidential Citizens Medal, the Department of Energy Gold Award, A Magyarsag Hirneveert Dij, the Harvey Prize from the Technion-Israel Institute, the Corvin Award from Hungary, etc.

Books written by Edward Teller include:

Energy from Heaven and Earth (W.H. Freeman, 1979), Pursuit of Simplicity (Pepperdine Press, 1980), Better a Shield Than a Sword (Free Press, 1987), Conversations on the Dark Secrets of Physics (Plenum Press, 1991), A Twentieth-Century Journey in Science and Politics (written with Judith Shoolery, 2001), etc.

Teller was born on the 15th January, 1908 in Budapest. He undertook his studies at the upper secondary school which was founded by Mór

Kármán, whose son was the famous rocket scientist Theodore von Karman.

He undertook his academic training in Germany and studied for his Ph.D. in physics under Werner Heisenberg at the University of Leipzig in 1930.

After leaving Leipzig for the University of Göttingen, Teller continued his close relationship with Heisenberg. In Göttingen he collaborated from 1930 to 1933 as a research associate.

When Hitler rose to power in January 1933, Teller left Germany, going first to the Institute for Theoretical Physics in Copenhagen for a year and then from 1934-5, he worked as a lecturer at the City College of London.

In Copenhagen he met his friend George Gamow, who invited him to work at the University of George Washington. In 1935, Teller came to the United States with his wife and he became a US citizen in 1941. Many famous universities in the USA competed for him. In 1942 he worked together with Enrico Fermi at Columbia University. He witnessed the development of the theory of relativity and quantum mechanics. His early work concentrated on applying this new quantum theory to explain diverse phenomena.

The person who developed the initial concept of the atom bomb was Szilard. The project was started by a letter, written by Leo Szilard (and maybe Eugen Wigner) and addressed to president F. D. Roosevelt. On the second of August 1939 Einstein signed the letter. At this historical moment Edward Teller was present too.

In 1942, Teller joined the Manhattan Project. He was busy with research on fusion reaction, theoretical calculations of the effects of a fission explosion and work on the first nuclear reactor during the Second World War.

In 1943, at Los Alamos Scientific Laboratory he examined, together with some others, the possibilities for thermonuclear power. The father of the Manhattan Project, Robert Oppenheimer, who devised the first atomic bomb together with others, was there as well.

Teller supported the hydrogen bomb against the opposition of J. Robert Oppenheimer. In 1954, during the commission's hearing about Oppenheimer's security clearance, Teller attested that he regarded Oppenheimer loyal to the United States. Teller's well-known statement was: "I would prefer to see the vital interests of this country in hands that I understand better and therefore trust more".

This statement was regarded as an intolerable insult to ethics by the majority of the American scientific society; therefore Teller was not accepted forever.

Many scientists considered Edward Teller as a controversial figure because of his idea about nuclear weapons and national security. Teller recognized that the state's security and civil defence meant an application of science and technology. The competition between the United States and the Soviet Union resulted in the birth of the controversial weapon, the superbomb.

After becoming a professor at the University of Chicago (1946-52), he returned to the Los Alamos Scientific Laboratory and became assistant director (1949-52).

In 1952 the nation's second Institute for the Development of Weapons was founded in Livermore: the Livermore Radiation Laboratory. Between 1954 and 1958, Teller was a consultant and cofounder to the institute and, for more than two years its associate director.

Between 1958-60 he again became the director of the Lawrence Livermore Laboratory.

He worked as a professor of physics at the University of California (1960-70) and as an associate director of the Lawrence Livermore Laboratory until his retirement in 1975.

Teller worked on nuclear weapons, nuclear reactor safety, ballistic missiles, submarines, underground nuclear testing, future energy sources and much else.

Between 1970 and 1975 Teller was a university professor at the University of California and from 1975 to 2003 the Director emeritus of the Lawrence Livermore National Laboratory. He was also senior research fellow of the Hoover Institution, Stanford University.

He continued, even to his very last day, to spend two days a week in the LLNL.

His greatness can be measured by his influence on people. His enthusiasm and passion together with his hopefulness for the future had an impact on science and on many scientists who collaborated with him and were influenced by him.

II. My meeting with Dr. Edward Teller in 2002

About 10 years ago I took part in a series of lectures in Budapest and among the lecturers was Dr. Edward Teller.

His captivating personality with his special logic, formidable intellect, and his enormously intuitive power fascinated me. I was a pupil in grade 8 when I read about him for the first time in the book: "Heller als tusend sonnen...(Ezer napnál tündöklöbben...)" written by Robert Jungk. Later, I entered the Fysikum Vetenskapslaboratorium (University of Stockholm) and my supervisor was Prof. Erik Johansson.

The environment there inspired me and I began to correspond with "the living legend", Edward Teller. After some letters I received a personal invitation to his residence in Palo Alto.

I met him with my husband on the 14th Jan 2002, one day before his 94th birthday.

Edward Teller was a member of the group called "The Martians", so nicknamed because they were thought to possess extraterrestrial intelligence and had a Magyar accent.

They were: Theodore von Karman, Leo Szilard, Eugene Wigner, John von Neumann and Teller himself. They grew up in Budapest in the fifth district and after secondary school they went to Germany and later to the U.S.A.

"There were so many brilliant Hungarian scientists that their colleagues at Los Alamos reached the conclusion that they possessed extraterrestrial intelligence and therefore were really agents from

another planet. Quite commonly, Teller, Szilard, Wigner, von Kármán, and von Neumann were referred to as 'The Martians' ". Energy and Conflict - The Life and Times of Edward Teller by Stanley A. Blomberg, Gwinn Owens 1976.

We began our discussion by speaking about Edward Teller's parents. He got his determined and persevering character from his father, who was a lawyer, while his artistic effort and his enthusiasm for poetry and classical music (Mozart, Bach, Beethoven, etc.) came from his fragile mother Ilona Deutsch.

She hoped that he would become a famous pianist. Already in his childhood the romantically poetical "self" of Edward Teller began to develop, together with his sensitivity for art.

In his words: "The man has two poles: his brain and his heart." If he had chosen music he would certainly have reached a similar success. His persistent character together with his talent would have helped him on the same way as it did in both physics and mathematics.

Teller told me that he fell in love with the world of numbers and figures at the early age of six, and with conscious encouragement from his parents he continued his mathematical studies.

This study resulted in friendship with another great mathematician John von Neumann. It was von Neumann, who had a great gift for solving difficult problems and we are indebted to him for his part in developing computers.

Teller told me about the tragic fight John von Neumann had with cancer, which attacked the part of his body that was the most important for him – his brain. During this time Edward Teller often visited his old friend, who needed medical treatment.

They had previously worked together. von Neumann was one of the best at preparing instructions. He helped with the small details which meant a great deal for the others and for the whole project in Los Alamos. Teller learnt a lot from him.

So we came onto the topic of teaching. Teller was a great physics teacher and mentor. We discussed the secret of how to be “a good teacher”. Teller was known to be a legendary lecturer and was very popular with the students. He participated in several programs for high school and elementary school students to inspire their interest in science.

His advice for us about an excellent teacher:

“If the teacher likes his or her occupation and is interested in the subject matter then he or she can convey it well.”

“A good teacher is someone who can share the latest breakthroughs in science with his or her students.”

“A good teacher is someone who can transfer the love he or she has for the subject to students.”

Maybe this thing explain the mystery of the schools from Gottingen and Copenhagen.

One of the questions was:

“How does a talented researcher or scientist become successful?”

He answered:

“Because he or she loves science, because he or she is willing to think over and consider new things. The fundamental point is that he or she is curious, from which new things can emanate. Research itself is neither good nor bad, everything depends on how it is used.”

The purpose and the deep motivation of Teller were always to understand the world. His scientific activity stemmed from a continuous curiosity:

“I have always had only one wish – to find out how the world is made up.”

In the scientific world it has always been difficult to accept new concepts and ideas but sometimes it is necessary. Research students generally use the experience of their Masters to further their knowledge and this can sometimes be a disadvantage.

“A qualitative change or revolution in science will be realized by people who dare to think in a different way.”

During our conversation we philosophised on conception being like multidimensional space and matter.

In the course of his long life Teller had the chance to meet many celebrated persons. We talked about some of them.

It is a generally well-known fact, according to Niels Bohr that an experienced person is one who familiarises himself with all frequent faults in his area through his instructive experiences.

According to Teller the scientist Niels Bohr has a brilliant personality. Teller said the following about him:

“As soon as a new thought arises and one considers that the old idea is at fault, one has to throw away the previous one. Bohr energetically opposed this.

One can understand a branch of science only if one immerses oneself in all of the faults which this branch has. Niels Bohr rejected faults but at the same time he liked them a lot.”

On one occasion Bohr incorrectly described a molecule of oxygen and Teller wanted to tell him this in a pleasant and good-tempered way. Instead of saying that he had made a false interpretation, Teller said:

“To describe a molecule of oxygen in this way is exaggerated.”

After this discussion Bohr glared at Teller (he was to all appearances angry) and Bohr said:

“Teller said to me that I exaggerate,. ..I say that Teller knows 100 times more about the molecule of oxygen than me. This is exaggerated, he can only know 92 times more than me.”

And he continued to talk. This was Bohr, a very special person.

Edward Teller met not only scientists but also presidents of the United States. To him the most pleasant meeting was with the former U.S. President Truman, when he reached the age of 70. At that time Teller gave a lecture about the hydrogen bomb and he received an invitation from the president. At the celebration Truman

spontaneously told Teller a funny story about a statement of his, which was the reason that he did not receive money from the tobacco industry.

Early on the 29th January, Truman gave an order relating to the thermonuclear program, which favoured the production of the hydrogen bomb. The war and uncertainty about the capability of Hitler, and later the Soviet Union, to produce a hydrogen bomb forced many scientists into a position that they would have chosen only in such an emergency.

In answer to my question of what his attitude was towards the title “The father of the hydrogen bomb” He answered:

“I worked on this quite a lot. I believe that if I hadn’t done it, the Soviets would have done the same thing anyway and I don’t think that the results would have been very nice.

I worked on this not because it was interesting. I believed that it was necessary and furthermore it was not only my work, there were many who worked on this. From my European background it followed that I did not like Russian Communism.”

I tried to choose parts of the whole talk, taped by video, that I considered interesting. For me it was a great honour to listen to the poetry which Teller wrote when he was about 16-18 years old. This shows a deep feeling.

Teller’s poetry (translated by Margit Grigory)

To seek, to expect, to desire nothing.
To love, to desire, to remain alone,
To look at the world with eyes closed,
To see what no man has seen before.
To love, to adore holy purity,
The wind, the clouds, the sun, and the dream.
To do the right thing, not for small change,
Nor for otherworldly eternal salvation.
To know that there is no goal,
To know that there is no God,
To be afraid that perhaps there is no justice,
To know that thought is ephemeral, the will is weak,
That I am dependent on blind chance.
And yet with stubborn hope still, still to believe
That what I accomplish is not in vain,

And to be able to rejoice at the great acquiescence
At death which cures joy and pain.

I finished my conversation with Edward Teller by reading poems, for over an hour, from pearls of Hungarian literature.

III. Teller with the help of notes from Chen Ning Yang



Chen Ning Yang with Teller in 1982. (Photo courtesy of Brookhaven National Laboratory.)

During the years from 1946 to 1949 at the University of Chicago the student Chen Ning Yang wrote his Ph.D. thesis, “On the Angular Distribution in Nuclear Reactions and Coincidence Measurements” under the guidance of Professor E. Teller.

In 1945 Yang called Teller and asked if he could work with him. They agreed to meet in front of the main door of the Physics Department. At that time the building was still occupied by the army because of the atom bomb research.

When Teller was a young student in Germany he had an accident and he lost one of his legs, which meant that a particular walking noise signaled that he was coming down the stairs.

“Are you Yang?” he asked. “Yes,” Yang answered. Teller asked Yang about the ground state wave function of the hydrogen atom. Yang had studied Quantum Mechanics in China and therefore this very fundamental knowledge was easy for him. “Good”, Teller said and Yang was accepted.

Teller had many students and he helped them a lot. His thoughts were very diverse and he was always ready to tell everybody about them. He usually gave the students one project every week. When they talked to him about the projects the following week he usually had forgotten the projects he gave. He was always full of both conceivable and inconceivable ideas, roughly ten every day. However, 95% of them were wrong. But it does not matter because if anyone has half a good idea every day, the achievement will eventually be great. His style impressed Yang deeply.

When Yang had just arrived at Chicago, Teller was teaching Quantum Mechanics. As he had a lot of work to do, he did not have time to prepare his lectures and sometimes he made mistakes in his lectures. After ten minutes, the aberration would become disastrous and in these situations one could learn how a senior physicist solved a problem.

This process was very educational for Yang. Through this kind of contact Yang understood what was important and unimportant for him. For Teller the meaning of an equation was more important than the equation itself.

In the autumn of 1946, Yang started to work in Professor S.K. Allison's laboratory. When he experienced difficulties with his experiment to resolve the $P_{1/2}$, $P_{3/2}$ states of He^5 , Teller suggested that Yang should abandon his plan to write an experimental thesis, and instead Teller would sponsor his papers as Yang's thesis. Yang was at first disheartened by the idea, but in a few days recovered and accepted Teller's suggestion with relief.

Teller's habit was to use conversation as an instrument of scientific investigation. He would ask a crucial question and then he looked for a partner to work with him on the explanation. Yang belonged to this group, off and on, for about two years.

Yang learned more group theory from Teller, who was just about thirty and had an intuitive grasp of the application of group theory in atomic and molecular physics.

Teller made the suggestion to treat the relativistic case in β decay.

"I still remember the first problem Teller asked me to work on: the difference of the K-capture lifetimes of Be^7 and Be^7O crystals" (C.N. Yang)

Teller suggested to Yang to use the Wigner-Seitz method for crystal analysis and the Thomas-Fermi-Dirac method for estimating the electron densities. The work was not published because Yang had no confidence about the validity of cancellations between large terms in the final results.

Talking to Teller was exciting because one could learn a lot from the conversation. Teller's ideas were not always correct but from a sceptical point of view, both parties benefited from the conversations. Here is an example:

After obtaining his PhD degree, Yang became an instructor at the University of Chicago. He attended unofficial seminars, between the departments of Physics and Chemistry, which were proposed by Fermi. They took place every week at coffee time for professors and research students. Anyone could talk about any new ideas or news. There were no specific topics, for example: carbon dating, speculation on the origin of elements....

Fermi, Teller and Urey attended the seminars regularly, so there was never a shortage of themes to discuss and it was never uninteresting. In 1949, Teller said that he had just received a phone call about a new meson discovery in Berkeley, namely that the π -meson disintegrates into two photons.

This was news and nobody in the seminar knew about it. "Teller immediately argued that the observation implied the π had zero spin" (C. N. Yang) Fermi asked him to prove this. Teller approached the blackboard and explained his argument but he was attacked by everyone because his argument was incomplete. (However the conclusion was correct.)

After the seminar, Yang thought the matter over. Although, Teller's argument was unfinished, it could be rescued and after a few days Yang worked out the correct selection rules in an article which made him proud. This is a concrete example of the benefit of talking with Teller.

In late March, 1948, Teller, Fermi and Wentzel went to the Pocono Conference. They returned with enthusiasm about J. Schwinger's talk on quantum electrodynamics and together with five graduate students, Yang worked several days in Fermi's office trying to understand Schwinger's method, but without result.

One can realize the influence Teller had on Yang from the description given for the Nobel Committee (1957), in which Yang emphasized that:

"... my three theses, written under Professors Ta-Yu Wu (B.Sc. thesis), J. S. Wang (M.Sc. thesis) and E. Teller (Ph.D. thesis) were instrumental in introducing me to my field of interest" (C.N. Yang)

In 1967, Edward Teller was 60. With an article about the classical solutions of pure gauge fields, T. T. Wu and C. N. Yang contributed to the celebration of Teller's sixtieth birthday. The aim of the article was to look for singularity-free classical solutions and to study perturbations around such solutions to obtain excitations.

"He is a Hungarian. His mind is very agile. He is also a theorist, broaching physics from phenomena. Because of developing the hydrogen bomb, Edward Teller was called "The Father of the Hydrogen Bomb".

However, he doesn't like this title. " (C. N. Yang)

IV. Similarities between the lives and activities of Teller and Sakharov.

Edward Teller (1908-2003) and Andrei Sakharov (1921-1989) grew up in a strong traditional family lifestyle with a fundamental passion for work and interest in literature, art and science.

Sakharov's family environment was respectful of professional competence.

Similarly Teller believed strongly in competition in science to bring out the best in all. Teller's career was often marked by his attraction to theoretical or computational challenges, or puzzling experimental results.

Both were key figures in the thermonuclear programmes and lived on opposite sides of the Iron Curtain. The United States and the Soviet Union were in rivalry for the hydrogen (fusion) bomb and thought that nuclear pressure was helpful.

The superbomb was a controversial weapon.

Both believed that thermonuclear reaction and its destructive power, which is the source of the energy of the sun and stars, was essential.

Teller and Sakharov have in common the fathering of the H-bomb.

Teller was concerned with the American atomic project from its start, before the United States entered World War II. In 1940 he was preoccupied with the idea of the hydrogen bomb. He returned to Los Alamos to work on the hydrogen bomb and contributed to the first plan of a thermonuclear weapon tested in 1952, after the Russians had tested their first atomic bomb in 1949.

In 1948 the government reported to a group of Igor Tamm to check the feasibility of an H-bomb plan. Sakharov was a member of this group and in a short time he invented a plan to devise the first Soviet thermonuclear bomb, which was tested in 1953. Sakharov's study was a major contribution to the H-bomb, which was tested in 1955.

Teller is: The father of the hydrogen bomb, similarly Sakharov is: The father of the Soviet hydrogen bomb. Both were top political and public celebrities and remained convinced that their work on nuclear weapons was a necessity for their own country as well as for the whole earth.

At Moscow University in the 1940s, Sakharov was considered one of the USSR's most brilliant intellects. After his doctorate, he was sent to a top-secret location to make plans for the improvement of the hydrogen bomb.

"I was working for peace, that my work would help foster a balance of power" (Sakharov)

"..in the 1940s and 1950s my position was much closer to Teller's, practically a mirror image (one only had to substitute USSR for USA, peace and national security for defence against the communist menace, etc.)... Unlike Teller, I did not have to go

against the current in those years, nor was I threatened with ostracism by my colleagues.” (Sakharov)

The Second World War was stopped by the bombing and destruction of Hiroshima and Nagasaki. Its inhabitants were martyrs for a war which should never have happened. The only consolation is that we have not had a Third World War and so a balance of nuclear terror between the two nuclear superpowers has worked. So we can deduce that American and Soviet atomic scientists helped to keep the peace.

Teller made a major contribution to the security and defence of freedom and world peace, extending from the beginning of the Second World War and throughout the Cold War.

Was this the only possibility?

“Each of us has a responsibility to think about this in global terms, with tolerance, trust, and candor, free from ideological dogmatism, parochial interests, or national egoism.” (Sakharov)

Sakharov became conscious that the patterns he had admired as a scientist could not coexist with Marxism and weapons. Tyrannical domination over information allowed Soviet party line to influence even the most excellent and the top. Sakharov desired to make his nation dominant enough to ensure peace after a terrible war

What can we learn from our history?

Already, Sakharov had realised that “all governments are bad and all nations face common dangers.” Maybe in the future we will have an institute whose leaders together with heads of states have as their unique goal, the well-being of the people. These leaders are not motivated by false pride or party and personal pecuniary goals and therefore they must do away with political parties.

With an allegoric example: The atoms have to connect very closely in order to form an object. What would happen if these atoms repelled each other instead of combining as they do?

Only by international collaboration and an understanding without violence and indignation can we reach a world without rearmament.

If we consider ourselves as intelligent beings we must think to the development of our human

consciousness too. In 1975, Sakharov received the Nobel Peace Prize. Teller was recognized with the prestigious Presidential Medal of Freedom.

“He changed the course of human history.”

“Edward Teller played a pivotal role in ending the Cold War. He has been a strong advocate for national defence and the cause of human freedom. The United States honours him for his excellence in science and in education, and his unwavering commitment to the nation.” (George Bush, President of the U.S.A.)

“I believe America and the free world owe Edward Teller a great debt of gratitude for his historic contribution to the defence of freedom, extending from the beginning of the Second World War and throughout the Cold War” (John Nuckolls, former Director, L.L.N.L.)

In accordance with some scientists Teller should have received the Nobel Peace Prize together with Andrei Sakharov, because he devoted his life to preserving freedom.

As a postscript I would like to mention that I read in LES CAHIERS DE SCIENCE & VIE [DOSSIER 100 ANS DE NOBEL, DANS LES COULISSES DU PRIX] about John von Neumann, Edward Teller and Theodore von Karman.

They were called “The Kings without crowns”, who ought to receive the Nobel Prize.