Proof by Erasure

The Life of John von Neumann

Feature Script by Constanze Kurz

version: 4.6.8.0 (final)

[Music: Phillip Glass *Closing* fade in, leave 10 sec.]

Speaker 1: Proof by Erasure. The Life of John von Neumann. An Audio Feature by the Hörspiel-Werkstatt of the Humboldt University of Berlin.

First Scene: Budapest (1903 to 1921)

[slow music fade-out]

Speaker 1: John von Neumann was born on December 28, 1903 as Janos in Budapest. He was Max Neumann's and Margaret Kann's first of three sons. In 1913, John's father Max received an inheritable title of nobility, but he chose not be addressed by his title. From the 1920s onwards John called himself, as an adult, „von Neumann".

Speaker 2: Around 1900 Budapest was a rapidly growing, booming European capital. The city in which von Neumann was born had an excellent education system, a world-wide renowned university and three high schools tailored to the academic elite.

Speaker 3: His father Max was a successful lawyer, who became the director of one of the leading Hungarian banks during the course of his career. His mother Margaret ran the household. She received an 18-room apartment as a wedding gift from her father, and it is in this apartment that John grew up with his brothers Michael and Nicholas. The parents' families were close to each other, and John enjoyed being in an extended family.

Speaker 1: They were non-practicing Jews. The family celebrated Jewish holidays, in the words of his younger brother Nicholas, as..

Reciter 1: ..secular family meetings.

Speaker 1: Already as a young boy John was interested in mathematics, the nature of numbers and the logic of the world around him. He and his father swapped jokes in classical Greek. He could also divide six-digit numbers in his head with little effort. Sometimes the von Neumann family entertained guests with John's ability to learn telephone directories by heart. A guest chose a column on a page at random from the directory. Young Johnny read the column several times, then he handed the book back to the guest. Thereafter he could respond to all questions, or specify names, addresses and numbers in the correct order. As an adult he competed against one of the first computers in high-speed calculating, and won. He was gifted with an almost photographic memory, and was able to quote a book or article verbatim after reading it only once. His second wife Klari Dan claimed in an interview:

Reciter (f): He won't remember what he had for lunch today, but he will remember everything on a page in a book he read fifteen years ago.

Speaker 1: And he was an avid reader: his father bought a complete library from an estate sale and John systematically read it from beginning to end. He had a very strong interest in reading the fourty-four volumes of the „General History in its Special Phases" of the German historian Wilhelm Oncken. Starting in his childhood, he memorized historical facts, and became an expert on Byzantine history and the early history of Latin America.

[music fade in: piano, gamut.]

Speaker 2: Sometimes his predilection for reading got him into trouble. During the brothers' piano lessons, Jancsi, as he was nicknamed, repeated scales again and again and completely ignored the piece of music which he should have being playing. His brother Nicholas remembers:

Reciter 1: It turned out that he had a book on the music stand and he was reading it - however, in order to be left in peace he played the scales.

[music ends.]

Speaker 3: Max Neumann noticed early on that his son was gifted. The von Neumann household was a congenial environment for a child prodigy's intellectual development. John's parents encouraged him and supported his interests, but were attentive not to pressurize him. As a result he developed not only an outstanding intellect, but also what many friends later called a likeable personality.

Speaker 1: John and his two brothers attended the Lutheran High School for boys because, in the words of Nicholas,

Reciter 1: „...it had a strong academic reputation in Budapest".

Speaker 1: Although the boys had extra lessons in Hebrew, they were never really able to write the language. It was only in Hebrew, handwriting, sport and music that John did not excel. He attended French and German classes before his sixth birthday just like his brothers. A short while later he began to learn Italian and English. Nevertheless, his strong Hungarian accent persisted throughout his life. Other subjects were easy for him: His brother remembers that John only spent a few minutes with his homework for the next day and then threw the books aside. Despite this lack of preparation he could take part in the lessons just as if he had conscientiously done his homework.

Speaker 2: Upon entering High School, he was introduced to a mathematician at the university who came regularly to the von Neumann household to work with John. In 1922, at the age of 17, he published his first paper on minimum polynomials in the journal of the German Mathematical Society.

Speaker 3: In the middle of John's school days the First World War ended and the Empire collapsed. For a short time a communist regime seized power. After three months the von Neumann family left their country, but returned three weeks later, after the regime had been toppled. Despite the brevity of this experience, John developed a lifelong distrust of communism.

[Music: *Children's Song No. 1*, leave during the transition, fade out during the next scene.]

Second Scene: ex ungue leonem (1921 to 1931)

Speaker 1: After John's final school examinations in June 1921 he had to select a suitable field of study. Despite his obvious technical ability, his father Max Neumann wanted his son to prepare for a career in business. He encouraged him to become a chemical engineer, although John had only little interest in chemistry or engineering. At that time being a chemical engineer was a respectable career, which guaranteed a life of ease. Thus von Neumann embarked upon a career partly planned by his father. He spent two years studying in Berlin. Thereafter he completed the entrance exam at the famous Swiss Federal Institute of Technology in Zurich, at which in 1895 his subsequent colleague Albert Einstein had first been refused admission.

Speaker 2: It was quite evident that John, if he were to pursue a mathematical career, would have to leave Hungary. The spiritual home of advanced mathematics was Germany, particularly Berlin and Göttingen. David Hilbert led the effort to reform the foundations of mathematics at the University of Göttingen. While studying chemical engineering in Zurich, he began his dissertation in mathematics at the University of Budapest.

Speaker 1: He was awarded outstanding marks in mathematical examinations although he had not participated in one course. In 1926 von Neumann received his diploma as a chemical engineer in Zurich. As a result of his interest in mathematics, he kept in touch with the mathematics professors Hermann Weyl and George Polya, who both taught in Zurich. While still a student he even taught one of Weyl's courses during the professor's absence. Later George Polya would say:

Reciter 1: Johnny was the only student I was ever afraid of. If in the course of a lecture I stated an unsolved problem, the chances were he'd come to me as soon as the lecture was over, with the complete solution in a few scribbles on a slip of paper.

Speaker 1: Von Neumann received his doctorate summa cum laude in mathematics from the University of Budapest in the spring of 1926. He succeeded in setting up a proper axiomatic formulation of the fundamental branch of mathematics, set theory. In 1922, at the age of only 17, he had already finished a first version of this work. Herbert Fraenkel received this manuscript and remembers in a letter:

Reciter 1: Around 1922-23, being then professor at Marburg University, I received a long manuscript of an author unknown to me with the title "Die Axiomatisierung der Mengenlehre", which eventually became his doctoral dissertation. I was asked to express my views since it seemed incomprehensible. I don't maintain that I understood everything, but enough to see that this was an outstanding work and to recognize *ex ungue leonem*.

Speaker 3: Ex ungue leonem - you may tell the lion by his claws. These were the words that Daniel Bernoulli had said two and a half centuries before about Isaac Newton.

Speaker 2: Beginning in 1927, von Neumann applied the axiomatic approach to the new discoveries in physics. The exciting event at Göttingen in 1925 was Heisenberg's development of a quantum theory which had only received its name in that year. At this time the scientific world was split into proponents and opponents of the physicists Werner Heisenberg, Max Born and Pascual Jordan. The representatives of the competing theories insisted on the superiority of their respective theory. Von Neumann appeared on the scene and moved the theory of quantum mechanics forward. He wanted to find out what both theories, wave mechanics and matrix mechanics, had in common. He provided the first rigorous axiomatic treatment of quantum mechanics and brought many mathematicians into agreement with this new theory. Von Neumann's ideas were later replaced by the models of Paul Dirac.

Speaker 1: After his work on formalizing quantum mechanics he worked intensively for different academic conferences and colloquia. He produced original papers in rapid succession in a variety of fields: logic, set theory, group theory, and operator theory. At the end of 1929, with scarcely 26 years, his name stood on 32 publications, all in the German language. Each one was written in a logical and accurate style so that other mathematicians could integrate his ideas into their work. In conferences and seminars von Neumann always tried to avoid lively ideological discussions with one of his colleagues by telling jokes or stories. Or he revealed some interesting facts on ancient history in order to change the topic.

Speaker 3: Von Neumann was a mathematical craftsman, a true virtuoso, and now an ascending star in the scientific world. And he was a young man who wanted to further the course of progress. In spite of his exceptional youth, he became a Privatdocent in the autumn of 1927, lecturing in mathematics at the University of Berlin. He was the youngest Privatdocent to have ever been appointed.

[Music: Children's Song No. 3, leave during the transition, fade out next scene.]

Third Scene: Princeton (1931 to 1938)

Speaker 2: In the 20s and 30s of the 20th century the European supremacy in the range of scientific theories reached its highest level - and its turning point. The shadow of coming events, of Hitler's rise in Germany, and the premonition of a world war loomed ominously. Political tensions intensified and because of the growing anti-Semitism the Jewish scientists left German universities. And the United States increasingly used its economic power in order to establish its intellectual and cultural supremacy. A symbol of this development was the foundation of the Institute of Advanced Study in Princeton in 1930. It was fast becoming a way station for an increasingly large number of displaced European scientists. At the end of the third decade of the century Princeton, not Göttingen, would be the scientific center for mathematics and theoretical physics.

Speaker 3: In autumn 1929 von Neumann was invited to come to Princeton and hold lectures on quantum theory. He accepted the appointment. Already after a short stay he determined that this country and this institute were a very good fit.

Speaker 1: But he didn't want to be completely Americanized. He maintained his Hungarian accent. Goldstine voiced the assumption:

Reciter 2: He pronounced *Integer* as *Integher*, but every now and then he would say it right. But then he quickly corrected himself and again said it in his own style.

Speaker 1: From 1930 to 1933 von Neumann often lectured to college groups in Princeton and enjoyed it immensely. It inspired him and he usually spoke without notes. He was said to be an indifferent teacher. His lectures were popular, though he was not easy to follow because he talked very rapidly. Stories are told of his lecturing while writing on the blackboard and erasing what he had written so quickly that students never got a chance to see it. In one of these lectures a colleague made an often quoted remark. He waited until John terminated his proof and then said:

Reciter 1: I see. Proof by erasure.

Speaker 1: At the age of 29 he was promoted to a permanent position at Princeton. Von Neumann was earning 10,000 dollars a year from the institute, a good academic salary for the time. John was a very young professor at the Institute. One of his colleagues remembers:

Reciter 2: He was so young that most people who saw him in the halls mistook him for a graduate student.

Speaker 2: Von Neumann had an office near Einstein's, at that time already a famous professor. They were colleagues, but the two were never close. A member of the institute said:

Reciter 2: Einstein's mind was slow and contemplative. He would think about something for years. Johnny's mind was just the opposite. It was lightning quick – stunningly fast. If you gave him a problem he either solved it right away or not at all. If he had to think about it a long time and it bored him, his interest would begin to wander. And Johnny's mind would not shine unless whatever he was working on had his undivided attention.

Speaker 3: Von Neumann spent summers in Europe on working vacations. Upon being offered the job in Princeton, he resolved in 1930 to marry his girlfriend, Mariette Kovesi, in Budapest. They spent their honeymoon on a cruise to New York. Unfortunately the largest part of the journey was overshadowed by Mariette's unexpected seasickness. In 1935 Mariette gave birth to a daughter, Marina, who works today as an outstanding academic economist and professor of business administration at the University of Michigan. Von Neumann loved his daughter, but did not assist her education. His wide range of interests did not include household details: these were for the women and servants. But von Neumann had a special relation to the world of children. Herbert York, a subsequent colleague, tells about John and his relationship to children:

Reciter 2: Von Neumann was extraordinarily intelligent and interested in everything… My three- and five-year-old daughters delighted in climbing on him when he came to call at the house. He looked like a Cherub and sometimes even acted like one.

Speaker 1: Meanwhile, von Neumann had become world-famous within his discipline because of the broad spectrum of his interests and the fertility of his mind.

Reciter 1: Most mathematicians prove what they can; von Neumann proves what he wants.

Speaker 3: Stories paint Johnny, as he was called, as an occasional heavy drinker and an aggressive and inconsiderate driver, which cost him approximately a car per year. According to legend, a junction in Princeton was called von Neumann's Corner after several accidents. He was regularly arrested because of driving too fast. After one of his accidents he had the following explanation:

Reciter JvN: I was proceeding down the road. The trees on the right were passing me in an orderly fashion at 60 miles an hour. Suddenly one of them stepped out into my path. Boom!

Speaker 2: His associates remember von Neumann chiefly as a sociable, witty, party-loving mathematician. Stories say that von Neumann upon entering an office where a pretty secretary was working would habitually bend way over, more or less trying to look up her dress. The von Neumann house became a center for social gatherings at the legendary Princeton Parties. A participant remembers:

[Sounds of party, voice tangle, glasses rattling and clinking, ice cubes etc]
[Music: *A Wonderful Guy*]

Reciter 2: They were unbelievable. The stories you read about those parties, they're not exaggerations. Von Neumann was a fantastically witty person, a lusty person. He knew how to have a good time.

Speaker 3: A typical habit of von Neumann led to many cocktails being tipped over at the parties: If someone described a problem while standing, Johnny would always begin to prance from one foot to the other at a certain stage of his ruminations. He often simultaneously stared at the ceiling and mumbled or hummed.

[Sounds and music end.]

Speaker 1: On one of these occasions someone described the fly puzzle to him:

Reciter 1: Two cyclists 20 miles apart are moving toward each other; each one is going at a speed of 10 miles per hour. A fly starting from the front of one wheel flies back and forth between them at a rate of 15 miles per hour. It does this until the bicycles collide and crush the fly to death. What is the total distance the fly has flown?

Speaker 1: When this problem was posed to John von Neumann, he immediately replied:

Reciter JvN: 15 Miles.

Speaker 1: The poser was disappointed: "Oh, you already know the trick?"

Reciter JvN: What do you mean, trick? I just added up the infinite series.

Speaker 1: When Johnny was later teased about this story, he always attached importance to the fact that the numbers given to him were not that simple...

Speaker 2: Von Neumann held his parties regularly, at least once a week, and he loved to discuss history. His knowledge was encyclopedic, and what he enjoyed most and knew best was ancient history. Once, a famous expert on Byzantine history attended a party. Another participant of this party remembers:

Reciter 2: Johnny and the professor went into a corner and began discussing some obscure facet of Byzantine history. Then an argument arose concerning a date. Johnny insisted it was this, the professor that. Finally, they consulted a reference text and discovered that Johnny was in the right. A few weeks later the professor was again invited to the von Neumann house. He called Mrs. von Neumann and said jokingly: "I'll come, but only if Johnny promises not to discuss Byzantine history. Everybody thinks I am the world's greatest expert on the subject and I want them to keep thinking that."

Speaker 3: In his private life he was often shortspoken, possessed by his thoughts and his work. The emotional gap between his lively 26-year-old Mariette and the now 31-year-old, respectable academic grew. She left him in 1936. The separation agreement gave Mariette child support for Marina. Von Neumann then rekindled a relationship with a childhood sweetheart, Klari Dan, during a trip to Europe. She and Johnny married on November 17, 1938.

Speaker 1: Von Neumann had not been a great one for physical exercise, but he was at least average in being energetic and active. He was small and plump, with a large forehead and a smooth, oval face. His hairline had receded to the top of his head. He did not particularly pay attention to his health, but did not smoke. Klari said later:

Reciter (f): He can count anything except calories. Unlike many mathematicians, he is a gifted calculator. Armed only with a pencil, he can easily keep pace with a desk adding machine. But when he counts up his calories for the day, he always makes mistakes in his favor.

Speaker 1: He paid great attention to the results of other mathematicians. Already around 1928 an essay of the mathematician Armand Borel inspired him to his most original work, game theory. Von Neumann found a proof of the general minimax theorem, noteworthy for its great generality and simplicity. His theory of games, outlined in a book which he published in 1944 in collaboration with the Economist Oskar Morgenstern, opened up an entirely new branch of mathematics. During the 1930s game theory was not an active field of research. But the book *The Theory of Games and Economic Behavior* has become a scientific best seller. The theory is now used in economic science, jurisprudence, political science and sociology.

Speaker 2: Von Neumann assumed that an economic situation can be understood as a game between two or more players. He liked to use game-theoretical concepts to describe practical situations and evaluations of tactical situations. But did John even use his ideas in his political thinking and work? The road which he would take in the following years leads one to assume this to be the case. He seems to have thought the unthinkable, a nuclear strike, in terms of game theory.

[Music: *Children's Song No. 4,* leave during the transition, fade out next scene.]

Fourth Scene: Los Alamos (since 1938)

Speaker 1: At the beginning of 1941 President Roosevelt authorized the development of the first atomic bomb. He committed more than two billion dollars to the project. In the initial phase John, now a citizen of the United States, was not involved, but his three Hungarian compatriots Eugene Wigner, Leo Szilard and Edward Teller were. In late 1943, Robert Oppenheimer asked von Neumann to become a consultant for the top-priority, highly secret Manhattan Project. As a consulting mathematician, he regularly showed up in Los Alamos to solve mathematical problems and to serve his adopted country.

Speaker 2: The scientists at Los Alamos were used to conducting scientific experiments. Developing experiments with weapons of mass destruction is difficult. They needed some way to predict what was going to happen in these complex reactions without actually performing them. Von Neumann was admired by the physicists, who regarded him as a peripatetic genius, an oracle, and a problem solver. But von Neumann's contribution was, characteristically, not so much to solve problems, but to help set them up that they could be solved. Herman Goldstine later summarized the reasons why John von Neumann was exactly the best scientist for this kind of work:

Reciter 2: Von Neumann possessed, along with all his other accomplishments, a truly remarkable ability to do very elaborate calculations in his head at lightning speeds; this was especially noticeable when he had to make rough order of magnitude estimates mentally and in so doing called upon an unbelievable wealth of physical constants he had available.

Speaker 2: There were two competing possibilities for the planned bomb, one with uranium as fissile material, the other with plutonium. It was clear that either the uranium or plutonium had to be compressed very quickly. Although von Neumann did not work on the technology of the plutonium bomb initially, it was in fact *his* idea to use implosion, as a method of detonating the bomb.

Speaker 1: Apart from his work on the complex calculations that would tell whether the implosion device would detonate the atomic bomb, and the mathematication of development, von Neumann dealt with computations to establish the optimum height at which it had to be detonated. President Eisenhower said in 1956:

Reciter 1: Dr. von Neumann, in a series of scientific study projects of major national significance, has materially increased the scientific progress of this country in the armaments field. Through his work on various highly classified missions performed outside the continental limits of the United States in conjunction with critically important international programs, Dr. von Neumann has resolved some of the most difficult technical problems of national defense.

Speaker 3: As a prominent mathematician he was influential because his judgement and reasoning were widely respected in Los Alamos. But von Neumann was also interested in gaining political influence. He became one of only two representatives from Los Alamos to be part of the ten man Target Committee that drew up the list of targets for the atomic bombing of Japan. He participated in selecting Hiroshima as a suitable target.

Speaker 1: Von Neumann was no militarist, he didn't promote armament. But he believed that the only possibility for the world to prevent a destructive conflict would be nuclear deterrence. By 1950 von Neumann was known to associates as a resolute supporter of preventive war. He was determined to defend his adopted country with as much armed might as possible.

[Eye-witness report starts.]

[Report ends, 10 seconds sound of wind.]

Fifth Scene: Calculating Machines

[Music: *Glass Vessels* fade in.]

Speaker 2: Historians identify the Second World War as a turning point in the development of computer technology. During the early 30's progress on computer systems for scientific applications was slow. The war was one of the reasons for pressing for the development of electronic computers, with whole new industries being born as a result. The calculating machines were useful for ballistic equations, bombing and firing tables, fire control, and related scientific problems. The U.S. Government has been a major force in launching and nurturing the computer age, and invested a substantial amount of money in the development of computers.

[Music ends.]

Speaker 1: The ENIAC, the Electronic Numerical Integrator and Computer, was a war-time project funded by the U.S. Army. Shortly after America's entry into the war, the machine brought together the needs of the Manhattan Project with the capabilities of the engineers building computers. The mathematician Herman Goldstine, then a first lieutenant, supervised the development of the ENIAC prototype. In August 1944, while Goldstine was waiting for a train, John von Neumann wandered up the station platform in Aberdeen:

Reciter 2: Prior to that time I had never met this great mathematician. It was therefore with considerable temerity that I approached this world-famous figure, introduced myself, and started talking. Fortunately for me von Neumann was a warm, friendly person who did his best to make people feel relaxed in his presence. The conversation soon turned to my work. When it became clear to von Neumann that I was concerned with the development of an electronic computer capable of 333 multiplications per second, the whole atmosphere changed from one of relaxed good humor to one more like the oral examination for the doctor’s degree in mathematics.

Speaker 2: Von Neumann became keenly interested in this machine. His expertise in hydrodynamics, ballistics, and game theory was put to good use in this project. He quickly became involved with the logical structure of the machine. In 1945, thanks to a financial effort which von Neumann’s political connections and influential relationships guaranteed, it performed calculations at 5,000 operations per second. Once, in 1949, von Neumann said:

Reciter JvN: It would appear we have reached the limits of what it is possible to achieve with computer technology, although one should be careful with such statements; they tend to sound pretty silly in five years.

Speaker 1: In 1983, his daughter said:

Reciter (f): If anyone had ever told him that General Motors, the company where I was an executive for some thirteen years, would produce and utilize literally millions of computers every year, I think he would have been stunned. And the notion of adults campaigning against computers as corrupters of youth would have amused and secretly pleased the childlike aspect of his personality.

Speaker 1: In June 1952, von Neumann's computer was completed at the Institute in Princeton. The architecture of this machine became the standard for all following commercial computers. The demonstration problem dealt with Kummer's conjecture, a problem in prime number theory. To celebrate the unveiling, von Neumann gave yet another party. There in his living room was a scale model of the Institute's computer - it was sculpted in ice.

Speaker 2: The importance of computers for science was recognized undoubtedly by John von Neumann. He undertook a theoretical study of computation that demonstrated that a computer could be able to execute any kind of computation effectively by means of proper programmed control without the need for any changes in hardware. In June 1945, he published a paper entitled "First Draft of a Report on the EDVAC," in which he presented all of the basic elements of a stored-program computer. His contribution to the early development of electronic computing machines, both to the theory and to many details of implementation, can hardly be overstated. Herman Goldstine calls this report…

Reciter 2: … the most important document ever written on computing.

Speaker 1: In the 50s von Neumann became a scientific advisor and consultant to IBM to review proposed and ongoing advanced technology projects. One day a week, he held court at Madison Avenue in New York. John Backus remembered von Neumann first heard about the Fortran concept in 1954. He was unimpressed and asked:

Reciter JvN: Why would you want more than machine language?

Speaker 1: Frank Beckmann, who was also present, recalled that von Neumann dismissed the whole development as …

Reciter JvN: …but an application of the idea of Turing's Shortcode.

Speaker 1: Donald Gilles, one of von Neumann's students at Princeton, recalls that graduate students were being used to hand assemble programs into binary for their early machine. They were written directly in machine language, composed of long strings of ones and zeros. Gilles took time out to build an assembler, but when von Neumann found out about it he was very angry:

Reciter JvN: It is a waste of a valuable scientific computing instrument to use it to do clerical work.

[Music: *Children's Song No. 4,* leave during the transition, fade out next scene.]

Sixth Scene: Georgetown, Washington, D.C.

Speaker 1: Apart from his research on computers during and after the war, von Neumann's scientific and political interest in nuclear weapons also grew. In 1946, he used his political influence in a hearing of the senate committee for atomic energy. He succeeded: 500 million dollars were granted for the continuation of atomic research. Von Neumann was politically conservative, but no reactionary. He justified his active support and his participation in the nuclear research with his political opinions. As a result of the Hungarian communist regime which he himself had experienced in his youth, he was convinced that Communism should be defeated under any circumstances.

Reciter JvN: I am violently anti-Communist, and I was probably a good deal more militaristic than most… My opinions have been violently opposed to Marxism ever since I remember, and quite in particular since I had about a three-month taste of it in Hungary in 1919.

Speaker 1: In 1957, Life Magazine reported that von Neumann had been a proponent of a preemptive atomic attack by the United States in a war with Russia:

Reciter JvN: If you say why not bomb them (the Russians) tomorrow, I say why not today? If you say today at five o'clock, I say why not one o'clock?

Speaker 2: Von Neumann was known as quite hawkish at that time. But friends of the mathematician didn't compare his behavior with a hawk, however. Rather it was similar to an owl, which is not only sage, but also has claws.

Speaker 1: Because of his scientific abilities and his experiences in nuclear research von Neumann became a member of the Atomic Energy Commission in 1952. This commission was the most important U.S. government agency in developing nuclear arms. In the commission President Truman essentially supported the viewpoint of von Neumann. In 1954, the notorious Oppenheimer hearing, which resulted in the loss of Oppenheimer's security clearance, caused many in the scientific community to express their outrage over the smear campaign. The commission soon made efforts to reconcile with the scientific community. Von Neumann defended Oppenheimer against his attackers and spent numerous hours trying to urge his own views on him. But he opposed Oppenheimer because of his stance regarding the H-bomb, and because of his left-leaning politics.

Speaker 2: In the 50s von Neumann was worried about Soviet progress in military technology. Aside from the design of bombs, von Neumann took an early interest in the development of missiles. Since 1954 he chaired the Atlas Scientific Advisory Committee which monitored research progress and sought to speed up development of missiles.

Speaker 1: Lucid, logical thinking joined with a respect for concrete and detailed facts had become von Neumann's habitual response to complex scientific problems. The chairman of the Atomic Energy Commission, Lewis Strauss, remembers:

Reciter 2: If von Neumann analyzed a problem, it was not necessary to discuss it any further. It was clear what had to be done.

Speaker 3: Von Neumann always had a very extensive and diverse consulting activity not only in government but also in the private sector. Because of his new position as commissioner and his consulting activities he and his wife Klari moved to Georgetown in Washington, D.C. in 1955. Klari reports:

Reciter (f): During the day he works in his offices at the Atomic Energy Commission. At night scientists in the many other fields he is interested in come to visit him. I am his night secretary. I entertain visitors and pass them into him, one at a time. Then comes the hour when people normally go to sleep. Johnny goes to sleep too. But to him sleep is part of his work. He believes much of mathematics is done subconsciously. He will go to sleep serenely with an unsolved problem and wake up at three in the morning with the answer; his mind has done it for him while he slept. Then he goes to his desk and phones his associates. One of his requirements for an associate is that he not mind being awakened in the middle of the night. Johnny will work until the morning and then go to his office as chipper as a lark.

Speaker 3: John had only worked at the commission for a few months before the pain in his left shoulder started. After two investigations bone cancer was diagnosed and John was admitted soon thereafter to a hospital. The cancer had already metastasized.

Speaker 2: Perhaps his disease was a result of having been witness to an atomic bomb test ten years earlier. But he continued to work - even harder. He set up office in his room in the hospital and, still performing his duties, constantly received visitors. Already in a wheelchair, his last public appearance came in 1956 when President Eisenhower presented him with the Medal of Freedom at a ceremony at the White House.

[Music: Phillip Glass *Opening* fade in.]

Speaker 3: As a person who lived by his thought processes, it was a terrible experience when his mental acuity diminished. His friend Edward Teller said:

Reciter 1: I think that von Neumann suffered more when his mind would no longer function, than I have ever seen any human being suffer.

Speaker 1: A deep despair came upon von Neumann when he knew that he was dying, for it was impossible for him to imagine that he would stop thinking. He died of cancer at 53, on the 8th of February 1957, in Washington, D.C, and was buried in Princeton. Paul Halmos wrote in his obituary:

Reciter 2: The heroes of humanity are of two kinds: the ones who are just like all of us, but very much more so, and the ones who, apparently, have an extra-human spark. We can all run, and some of us can run the mile in less than four minutes; but there is nothing that most of us can do that compares to the creation of the Great G-minor Fugue. Von Neumann's greatness was of the human kind. We can all think clearly, more or less, some of the time, but von Neumann's clarity of thought was orders of magnitude greater than that of most of us, all the time.

[Music ends.]

Speaker 1: Proof by Erasure. The Life of John von Neumann. An Audio Feature produced by the Hörspiel-Werkstatt of the Humboldt University of Berlin. Performed by Kai Kittler, Jochen Koubek, Heinz Kuper, Constanze Kurz, Ina Kwasniewski, Jens-Martin Loebel, Marcus Richter. Script written by Constanze Kurz. Music by Phillip Glass, Chick Corea, Oscar Petersen. Sound recording and editing by Jochen Koubek. Special thanks to Heinz Kuper.