

The Creation Story

The opportunity to give this talk touches my heart, for several reasons. The subtitle of this Conference, from punched cards to the information society, traces a history in which my father, John von Neumann (or, to this audience, Neumann János) is a Founding Father. It is being held in the country of his birthplace, which he abandoned when he foresaw it being swallowed up by the Nazi sweep across Europe and which he never dared to revisit during his lifetime, while it was under the dominance of Soviet Communism. This occasion, celebrating the opening of a great new museum dedicated to the story of the modern computer and the world it has made possible, marks his triumphant, if sadly posthumous, return, with his daughter as his messenger.

As I'm sure you all know, my father led a double life: as a commanding figure in the ivory tower of pure science, and as a man of action, in constant demand as an advisor, consultant and decision-maker in the long struggle to insure that the United States would be triumphant in both the hot and the cold wars that together dominated the half century from 1939 until 1989. The line of demarcation between these two halves of his life is clear. During the first half, which spanned his youth in Europe and his early days in the United States, he made fundamental contributions in the realm of pure mathematics and mathematical physics, involving himself in some of the major scientific issues that roiled European intellectuals during the early part of the 20th century. In 1935, though, he symbolically put Europe behind him by resigning from the German Mathematical Society, writing, "...I cannot reconcile it with my conscience to remain a member of the German Mathematical Society any longer..." He was equally emphatic 20 years later, in explaining his reasons for coming to America: "I expected World War II, and I was apprehensive that Hungary would be on the Nazi side, and I didn't want to be caught dead on that side.

As soon as he had obtained American citizenship in 1937, von Neumann embarked on a collaboration with the US military that lasted the rest of his life, first with the Ballistics Research Laboratory of the Army Ordnance Department in Aberdeen, Maryland, then with the

Manhattan Project and, after World War II, with all three branches of the Armed forces, the Department of Defense, and the Atomic Energy Commission. His work in such disparate areas as game theory, digital computers, inter-continental ballistic missiles, meteorology, and other kinds of mathematical modeling were united by their relevance to real-world problems, including military, economic, and political applications. Although he remained on the faculty of the Institute for Advanced Study until 1955, the contemplation of pure mathematics in its tranquil surroundings was pushed aside by his involvement in crucial issues relating to the security of the United States. He had, as he put it, lost his purity, to the dismay of his mathematics colleagues at the Institute.

These two aspects of his persona, the ivory tower thinker and the man of action, combined to produce the “von Neumann architecture” of the modern stored-program computer. The deep understanding of mathematics, physics, and engineering that characterized his purely intellectual accomplishments provided the necessary brainpower; the commitment to freedom that spurred the man of action provided the motivation. Without the exponential increase in computational power and speed that the new computer design made possible, the Manhattan Project could never have produced on schedule the weapons that definitively ended World War II and kept the world in the tenuous stability of MAD (Mutually Assured Destruction) during the Cold War.

Some of you may have read *Turing’s Cathedral*, George Dyson’s fascinating, detailed account of how my father and his team built their machine at the Institute for Advanced Study. Here, I’ll only note that, although my father had hoped that his computer could be built in three years, it actually took six, from 1946 until 1952, before a celebratory cocktail party was in order. The party at our house had as its centerpiece an ice-carved model of the computer, which my father dubbed the MANIAC but which later was given a less playful designation as the IAS machine. The vacuum tubes were represented by silver thumbtacks, which of course started falling out as the ice melted. A close friend, Margaret Rabi, and I kept busy for a while replacing the fallen tacks, but eventually entropy defeated us and the computer became a formless puddle.

The fate of the celebratory ice-carving was, in a way, emblematic of the fate of the IAS machine itself. Opposition on the part of much of the Institute's faculty never really faded and, once my father had departed for Washington in 1955 to serve on the Atomic Energy Commission, some members of his team departed, and the ones that remained were poorly treated. At his death, in 1957, the computer project was closed, and the Institute's faculty passed a motion decreeing that henceforth no experimental science would be conducted there.

The machine itself, superseded by newer and faster models with the same basic von Neumann architecture, was dismantled and the brick building in which it was housed became a storage unit for cleaning and maintenance materials. Today, it is shared by a fitness facility and a preschool for the offspring of visiting members at the Institute. Until recently, a segment of the machine, which had been donated to the Smithsonian, was on display in the Museum of American History. With the latest remodeling, that too has been consigned to attic storage. But its millions, nay billions, of progeny shape nearly every moment of our waking lives.

Although he was a polymath, my father's genius did not extend to prescience in forecasting the future. He was, for example, profoundly pessimistic about even the short-term future of the human race, as he implied in an article he wrote for *Fortune* magazine in 1955, the year he was found to have the cancer that would kill him. Asked to give his views on America in 1980, he titled his response "Can We Survive Technology?" In it, he predicted that "Present awful possibilities of nuclear warfare may give way to others even more awful...In the years between now and 1980 the (global) crisis will probably develop far beyond all earlier patterns. When or how it will end—or to what state of affairs it will yield—nobody can say." Despite the ambiguous wording, this last sentence reflected his fear that mankind might not survive another 25 years, but instead become the victim of its own self-destructive inclinations. He had quantified this fear in a letter to his wife, Klari, in 1946 regarding the probable date of the next war: "...I don't think this is less than two years and I do think it is less than ten." By the time he wrote the article for *Fortune*, the ten years were almost up.

My father wasn't a very accurate prophet, either, regarding what turns the practical applications of his pioneering work would take. For example, he clearly expected that the

computer would have its impact primarily on scientific research and military work, even suggesting once that the world wouldn't need more than ten or dozen of them. He was particularly interested in its role in advancing the accuracy of weather forecasting, and ultimately, climate modification. I don't think progress in this area has been nearly as far or as fast as he hoped and expected. Similarly, I think he anticipated that the theory of games would have a more immediate impact on military and business decision-making than in fact it did. He might have found it a bit ironic that when finally, in 1994, the role of game theory in economics was recognized with a Nobel Prize, the prize went not to the inventors of the basic theory, von Neumann and Morgenstern (who were both long dead) but to the developers of important advances in the field. Unsurprisingly, one of the three winners was another Hungarian, John C. Harsanyi, who had attended the same high school, the Lutheran Gymnasium in Budapest, as my father.

On the other hand, if anyone had ever told von Neumann that the company I used to work for, General Motors, would produce and utilize literally millions of computers each year, with a growing number in each and every car it builds, not to mention the ones in its plants and offices, I think he would have been astounded. And the notion of adults fulminating against computers as corrupters of youth in the form of video games and revealing photos on Facebook would have amused and perhaps secretly pleased the playful, childlike side of his personality, reflected also in his love of children's toys. Three of his particular favorites, which sat on his desk and which he often studied intensely for long periods of time, were a bird perched upright on a metal stand that would lean over to drink from a water glass and then right itself on a precise schedule, a hand-blown glass tube filled with soap bubbles, and a wooden disc with everyday objects (a heart and a four-leaf clover, for example) painted on its face and a metal pointer that, when spun, would land on one or another of the painted symbols.

When I asked him why he found these toys so fascinating, he explained that each embodied some principle of mathematics or physics. Watching the changing pattern of the soap bubbles after he shook the glass tube, he contemplated the effect of surface tension in

making them obey the law of entropy; noting where the pointer on the wooden disc landed on spin after spin stimulated his ideas on the laws of probability. Had Legos been available at the time, he might have built a model of his computer from them.

Coming back to forecasting; my father foresaw the inadequacy not only of his own forecasts but of such forecasts in general. In that 1955 article in *Fortune*, he said: "All experience shows that technical changes profoundly transform political and social relationships. Experience also shows that these transformations are not a priori predictable, and that most contemporary first guesses concerning them are wrong."

On one particular issue, though, my father was eerily prescient, though it has taken more than 70 years for reality to catch up with his foresight. In 1946 he wrote to his friend and colleague at the Institute, the physicist Freeman Dyson: "I am thinking about something much more important than bombs. I am thinking about computers." Again, his focus was on computers as tools of war, this time in the form of weather control, which he saw as the most effective weapon in future hostilities. Today, efforts to manipulate weather, or rather, climate, are focused rather on the more peaceful goal of preserving the earth's habitability. But, in recent weeks, our newspapers have been carrying articles suggesting that cyber-warfare, another of those early computers' descendants, has replaced nuclear proliferation as the number one global threat.

And now a word about about John von Neumann's deep concern about his ongoing legacy, particularly during the last year or two of his life. He was occupied partly with immortality in the personal or religious sense, a fear that motivated his deathbed return to the Catholic Church, but that is a topic for another day. He was also profoundly concerned, however, with the nature of his legacy in this world, in two respects. One had to do with the durability of his work, his intellectual contributions; he was surprisingly insecure about whether his work would still be recognized "in a hundred years". Well, the hundred years he had in mind aren't up yet, but he might be reassured, not only by the discussion we are engaged in here, but also by the fact that the royalties I still receive on books he wrote in the 1930s, 40s, and 50s vastly exceed anything I receive on my own much more recent publications. Not to

mention the fact that the descendants of his “baby”, the stored program electronic computer, have profoundly affected every aspect of our lives.

The second focus of John von Neumann’s concern about his earthly legacy was, to put it simply, me. I was his only offspring and, toward the end of his life, he became acutely conscious that all his eggs were in one basket, genetically speaking (if biological inaccuracy can be forgiven for the sake of metaphor). So he put tremendous pressure on me to perform up to the peak of my abilities, and made clear his displeasure with the path I appeared to be taking. I got married a week after graduating from college, and he thought that this was a bad beginning, not because he wasn’t quite fond of my husband, but simply because he feared (and it was a reasonable fear, in the 1950s) that a woman who married young was very probably reducing her own chances of making a significant intellectual or professional contribution. His letters became increasingly desperate as my wedding drew closer and his illness advanced, begging me not to “tie yourself down at such an early age” and thus “throw away any chance of fulfilling your own talents.”

Statistically he was right, of course, but I like to think that in this particular case he was wrong. I’m no John von Neumann, obviously, but I have had a reasonably successful and highly rewarding career as an academic economist, a presidential adviser, and a corporate executive. In all these careers, I have been mindful of his insistence that it is immoral not to make maximum use of one’s intellectual capacities. Indeed, the most powerful motivator of my academic and professional life has been my determination to escape from the shadow of this larger-than-life parent, my desire to prove him wrong in his fear that my early marriage would thwart his hopes and ambitions for my own future. I was determined to prove that his expectations for my intellectual and professional success and my own for marriage and children with the man I had fallen in love with while still a teenager need not be mutually exclusive. With every new achievement in my life, with every barrier broken, came an overwhelming urge to say to my father “you see, I defied you by doing what I wanted, but I’m also doing what you wanted me to, after all.”

Because this shadow is a major theme of my memoir, *The Martian's Daughter*, which I will be happy to sign for anyone who chooses to buy a copy after this session, I will end with the final paragraphs from that book, which brings us back to Hungarian soil:

My father's presence was closest in 2003, when Hungary staged a national celebration commemorating the hundredth anniversary of his birth. I was invited to participate as an honored guest, an honor that carried with it one of the most hectic schedules I've ever encountered. A couple of weeks after finishing treatment for breast cancer, I found myself not only giving talks about my father at internationally attended meetings of the Hungarian Mathematical and Computer Science societies in Budapest, but also giving informal talks about him, in English, to students in schools all over Hungary.

Thank goodness it's a small country; Bob and I were transported to every corner of it in the cramped elderly vehicle belonging to one of my father's self-appointed promoters, who enthusiastically acted as our chauffeur. Some of the schools were actually named after von Neumann, but in all of them students knew who he was, what he had accomplished, and had created various exhibitions to honor him. I tried to imagine American high-school students according a long-dead mathematician the sort of veneration reserved here for sports and entertainment celebrities!

That week of talking about John von Neumann's life and accomplishments in the land of his birth brought closure for me, a recognition that what I'd feared were conflicting expectations—my father's, my mother's, society's and my own—that had shaped my life had finally converged. I had fulfilled my father's moral imperative that I make full use whatever intellectual gifts I had; my mother's ugly duckling had developed a swan's poise and self-confidence. A society where women head Fortune 500 corporations, where half the Ivy League universities and several of the leading public ones as well are headed by women, and where a female has been a serious contender for the nation's highest office, now allows the most daring and talented women expectations that far exceed mine. By their own lives, my husband and our children have given the lie to the fears of Bob's mother that all three would pay dearly for my career ambitions; my expectations of a close and loving family life have extended to

encompass a third generation. My father's shadow has lifted at last; if we meet again, it will be in sunlight.