On April 30, 1939, under the gathering storm clouds of war, the New York World's Fair opened in Flushing Meadows, in Queens. Its theme was *The World of Tomorrow*. Over the next eighteen months, nearly forty-five million visitors would be given a peek into a future shaped by newly emerging technologies. Some of the displayed innovations were truly visionary. The fair featured the first automatic dishwasher, air conditioner, and fax machine. The live broadcast of President Franklin Roosevelt's opening speech introduced America to television. Newsreels showed Elektro the Moto-Man, a seven-foot tall, awkwardly moving aluminum robot that could speak by playing 78-rpm records, smoke a cigarette, and play with his robot dog Sparko. Other attractions, such as a pageant featuring magnificent steam-powered locomotives, could be better characterized as the last gasps of the world of yesterday.

Albert Einstein, honorary chair of the fair's science advisory committee, presided over the official illumination ceremony, also broadcast live on television. He spoke to a huge crowd on the topic of cosmic rays, highly energetic subatomic particles bombarding the Earth from outer space. The event has been described as a comedy of errors. Einstein's talk could hardly be understood as the amplification system soon broke down. And the opening act—the capture of ten cosmic rays—ended with a spectacular debacle. The particles were transported by telephone line from the Hayden Planetarium in Manhattan to the fairgrounds in Queens, where bells and lights signaled their arrival. But when the tenth ray was captured, a power failure occurred to the great disappointment of the audience, which soon decamped. As the *New York Times* reported the next day, "The crowd dropped science in favor of a spectacle that they could applaud."

Two scientific discoveries that would soon dominate the world were absent at the World's Fair: nuclear energy and electronic computers.

Remarkably, the very beginnings of both technologies could be found at an institution that had been Einstein's academic home since 1933: the Institute for Advanced Study in Princeton, New Jersey. The Institute was the brainchild of its first director, Abraham Flexner. Intended to be a "paradise for scholars" with no students or administrative duties, it allowed its academic stars to fully concentrate on deep thoughts, as far removed as possible from everyday matters and practical applications. It was the embodiment of Flexner's vision of the "unobstructed pursuit of useless knowledge," which would only show its use over many decades, if at all.

However, the unforeseen usefulness came much faster than expected. By setting up his academic paradise, Flexner unintentionally enabled the nuclear and digital revolutions. Among his first appointments was Einstein, who would follow his speech at the World's Fair with his famous letter to President Roosevelt in

August 1939, urging him to start the atomic bomb project. The breakthrough paper by Niels Bohr and John Wheeler on the mechanism of nuclear fission appeared in the *Physical Review* on September 1, 1939, the same day World War II started.

Another early Flexner appointee was the Hungarian mathematician John von Neumann, perhaps an even greater genius than Einstein, of almost extraterrestrial brilliance. Von Neumann was one of the "Martians," an influential group of Hungarian scientists and mathematicians that also included Edward Teller, Eugene Wigner, and Leo Szilard, the physicist who helped draft Einstein's letter to Roosevelt. A well-told story in physics is that when a frustrated Enrico Fermi asked where were the highly exceptional and talented aliens that were meant to find Earth, an impish Szilard replied, "They are among us, but they call themselves Hungarians."

Von Neumann's early reputation was based on his work in pure mathematics and the foundations of quantum theory. Together with the American logician Alonzo Church, he made Princeton a center for mathematical logic in the 1930s, attracting such luminaries as Kurt Gödel and Alan Turing. Von Neumann was fascinated by Turing's abstract idea of a universal calculating machine that could mechanically prove mathematical theorems. When the nuclear bomb program required large-scale numeric modeling, von Neumann gathered a group of engineers at the Institute to begin designing, building, and programming an electronic digital computer—the physical realization of Turing's universal machine. As von Neumann observed in 1946, "I am thinking about something much more important than bombs. I am thinking about computers."

In his spare time, von Neumann directed his team to focus these new computational powers on many other problems aside from weapons. With meteorologist Jule Charney, he made the first numerical weather prediction in 1949—technically it was a "postdiction," since at that time it took forty-eight hours to predict tomorrow's weather. Anticipating our present climate-change reality, von Neumann would write about the study of the Earth's weather and climate: "All this will merge each nation's affairs with those of every other, more thoroughly than the threat of a nuclear or any other war may already have done."

A logical machine that can prove mathematical theorems or a highly technical paper on the structure of the atomic nucleus may seem to be useless endeavors. In fact, they played important roles in developing technologies that have revolutionized our way of life beyond recognition. These curiosity-driven inquiries into the foundations of matter and calculation led to the development of nuclear arms and digital computers, which in turn permanently upset the world order, both militarily and economically. Rather than attempting to demarcate the nebulous and artificial distinction between "useful" and "useless" knowledge, we may follow the example of the British chemist and Nobel laureate George Porter, who spoke instead of applied and "not-yet-applied" research.

Supporting applied and not-yet-applied research is not just smart, but a social imperative. In order to enable and encourage the full cycle of scientific innovation, which feeds into society in numerous important ways, it is more productive to think of developing a solid portfolio of research in much the same way as we approach well-managed financial resources. Such a balanced portfolio would contain predictable and stable short-term investments, as well as long-term bets that are intrinsically more risky but can potentially earn off-the-scale rewards. A healthy and balanced ecosystem would support the full spectrum of scholarship, nourishing a complex web of interdependencies and feedback loops.

However, our current research climate, governed by imperfect "metrics" and policies, obstructs this prudent approach. Driven by an ever-deepening lack of funding, against a background of economic uncertainty, global political turmoil, and ever-shortening time cycles, research criteria are becoming dangerously skewed toward conservative short-term goals that may address more immediate problems but miss out on the huge advances that human imagination can bring in the long term. Just as in Flexner's time, the progress of our modern age, and of the world of tomorrow, depends not only on technical expertise, but also on unobstructed curiosity and the benefits—and pleasures—of traveling far upstream, against the current of practical considerations.

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