The Future Is a Foreign Country

How we choose to think about what lies ahead may be more important in creating a future we can comfortably inhabit than all the technological change tomorrow will bring.

BY EDWARD TENNER

IN THE EARLY 1990S, I VISITED THE PRINCETON house in which Albert Einstein had lived while a professor at the Institute for Advanced Study from 1936 until his death in 1955. It was one of many graceful Greek Revival structures built in the 1830s and '40s by a Massachusetts-born carpenter-architect, Charles Steadman, in what eventually became the fashionable western part of Princeton. For me, the real surprise in the house was Einstein's furniture, which had remained there as the property of the Institute. In the living room were several massive wooden cabinets in the neo-Renaissance style beloved by the upper-middle class during the opulent years after German unification in 1871. Einstein was known to scorn the pomp and formality of his bourgeois contemporaries. Why, then, were these giant pieces dominating the small, low-ceilinged space? One explanation is that the furniture had been inherited by Einstein's wife and cousin, Elsa, whose tastes were more conventionally German, and for whom the pieces may have been a precious link to an otherwise-lost heritage. But that does not explain why Einstein kept them after her death and left them to the Institute in his will (though he stipulated that his house never become a personal museum or shrine).

The example of Einstein is a good introduction to certain dilemmas of contemporary thinking about the future, whose border we are always crossing. The first dilemma is whether to assume that changes will continue along current lines, or that offsetting forces will neutralize or even reverse them. This is a choice between extrapolationism and compensationism. The second dilemma is a choice between affirmation and balance—that is to say, between whether we should accommodate our tastes and surroundings to scientific and technological change or live a countervailing life. Einstein is a compelling figure for the study of futurism because values—the key to all futurism, no matter how objective it purports to be—were so important to him. The physicist Gerald Holton has underscored, for example, the influence of Goethe and German romantic philosophy on Einstein's quest for the unification of physics.

Let us consider, then, the merits of extrapolationism versus those of compensationism. Einstein and his scientific contemporaries had different ways of looking at future tendencies. The Hungarian-born physicist John von Neumann (1903–57), who believed in the generally benign power of future technology to improve the lot of humanity, could be called a conservative extrapolationist. In *The Fabulous Future*, a book of essays about the world of 1980 sponsored by *Fortune* magazine in 1955, he envisioned that atomic power would make energy too cheap to meter. He expected this almost-free energy, along with computer power, to enable us to select our climate, and he

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thought that we should be prepared for serious domestic and international debates over how to use these newfound abilities. Though von Neumann's assertions have often been ridiculed, positive extrapolationism has sometimes proved justified. For example, reasonable flat charges for unlimited long-distance calling plans have been spreading, and most individual subscribers today pay a low flat fee for virtually unlimited Internet surfing. (Von Neumann's article, I should note, did not discuss these costs of information.)

Even in matters of energy, von Neumann's extrapolationism was not entirely wrong. Looking at the history of illumination from the domestication of fire by *Australopithecus* 1.42 million years ago to the introduction of the compact fluorescent lamp in the early 1990s, the economist William D. Nordhaus observed that the efficiency of lighting had increased from 0.00235 lumens per watt to 68.2778. From the heyday of ancient Babylonian oil lamps around 2000 B.C. to the early 19th century, the rate of increase in efficiency amounted to 0.04 percent per year. But in the two centuries between 1800 and 1992, it was fully 3.6 percent per year—and the quality of illumination was higher. So there had been a 1,200-fold improvement from Babylonian times to 1992. Nordhaus suggested that economists had been underestimating rather than exaggerating the impact of technological change on productivity and living standards. Today, rural Third World children can read by a light-emitting diode (LED) drawing only a tenth of a watt. A hundred watts can serve a whole village, according to the electrical engineer Dave Irvine-Halliday, founder of the Light Up the World Foundation. It is as though the 100-watt bulb in the architect lamp on my desk as I write this were divided into literally a thousand points of light.

Masakazu Takahata's *Crossing* (1999) captures the mixture of trepidation and elation surrounding the coming of the new millennium and an era of seemingly unrelenting fast-paced change.

Computing power has been increasing even more rapidly than lighting efficiency. The electrical engineering magazine *Spectrum* recently observed that, since the 1960s, the cost of producing transistors has dropped "from a dime a dozen to a buck for a hundred billion." Gordon Moore, a founder of Intel, predicted in the 1960s that the number of transistors on an integrated circuit would double every year. The actual time has turned out to be closer to 18 to 24 months, but the predictive power of Moore's Law shows no sign of slackening. It is the bedrock of extrapolationism, since whatever the goal, the brute force of more-powerful circuits appears to bring it closer every year.

Compensationists, by contrast, may welcome these trends, but they point to their self-limiting side. For example, as artificial lighting has spread over the past 100 years, it has interfered with natural human sleep patterns, and sleep deprivation reduces performance, increases the rate of accidents, and may even shorten lives, thereby offsetting the benefits Nordhaus cites. Computational power has countless benefits beyond the personal computer, but it also increases expectations as new versions of applications require all the new power—and often more. Faster new microchips also run hotter and draw more power, increasing the likelihood of blackouts.

And usability and reliability may actually decrease as processing power increases. That complaint is heard with greater frequency, for example, as luxurious new European automobiles grow more reliant on computer technology.

Higher expectations also tend to maintain real-price levels. Bill Machrone, former editor in chief of *PC Magazine*, has a law of his own: The computer you really want always costs $5,000—whether an Altair 8000B in 1976 or a top-of-the-line Apple Macintosh G5 with a wide-screen, flat-panel monitor today.

In environmental futurism, extrapolation is usually a sinister rather than a benevolent force. After *Limits to Growth*, the 1972 report to the Club of Rome, many extrapolationists (usually on the political left) viewed the unchecked growth of population and the spread of industrialization as preludes to famine and ecological catastrophe. Fortunately, the report was wrong. Despite an expanding global population, food production per capita has been increasing rather than dropping. Where hunger exists today, it is more likely to be caused by inequities of distribution than by shortfalls of production. Most demographers now predict that the world's population will peak in the middle of this century, then decline. But the good news for humanity does not necessarily extend to many other creatures, environmental advocates reply. The world's bounty has been paid for by dangerous levels of nitrogen in fertilizer, leading to perilous runoff into natural waters and a different food crisis: the impending collapse of many fisheries.

The principal battles being fought these days between compensationists and extrapolationists are about energy and, especially, climate change. Countering the positive extrapolationism of John von Neumann is the argument of some geologists, such as Princeton University's Kenneth S. Deffeyes, that we have already reached a global peak of oil production. This analysis, first advanced by M. King Hubbert in 1974, may be wrong, but it's consistent with recent production trends and with the doubts of some specialists that the proved reserves of the major oil companies are as big as advertised. Its defenders also note that, in 1956, Hubbert correctly predicted the 1970 peak of U.S. domestic petroleum production.

Although many earth scientists are (negative) extrapolationists, most economists seem to have remained compensationists. Human ingenuity is "the ultimate resource," argued the late Julian Simon in a book of the same title. Economists can point to improved exploration techniques, new ways to recover previously uneconomical reserves, and, above all, a range of other energy sources (coal, biomass, natural gas, safer nuclear plants, solar power, and so forth). In addition, there are more-energy-efficient technologies, such as hybrid automobiles, that can be tapped if Hubbert was right. So the exponential development of technology will offset the gradual decline of petroleum production—if decline is indeed inevitable.

THE CHOICE IS BETWEEN a material and artistic culture that reflects and even anticipates change and one that cushions the spiritual shocks of change.

Global warming is the great battleground between extrapolationism and compensationism. Whatever the role of human activity in increasing the concentration of greenhouse gases over the past two centuries, a significant increase in global temperatures appears inevitable in this century. At least until the 1980s, as the historian of science Spencer Weart observed in the journal *Physics Today*, climatologists doubted the very possibility of rapid change: "The experts held a traditional belief that the natural world is self-regulating: If anything started to perturb a grand planetary system like the atmosphere, natural forces would automatically compensate. Scientists came up with various plausible self-regulating mechanisms. . . . Stability was guaranteed, if not by Divine Providence, then by the suprahuman power of a benevolent 'balance of nature.' "

Today, both scientists and laypeople are more likely to envisage an unstable future and to worry about the robustness of natural systems. Yet the debate continues. The strongest positions are an extrapolationism that foresees likely catastrophic consequences and a compensationism that envisions a gradual trend with positive aspects that can be augmented by more market-based ingenuity. A leading exponent of the first alternative is Henry Jacoby, an economist at the Massachusetts Insti-

tute of Technology, who has used extensive computer modeling to arrive at a probabilistic view of global warming: There's a good chance that it will be gradual and amount to only a few more degrees Fahrenheit, according to Jacoby. There's also a small but disturbing chance that the increase could be as much as nine degrees. So limiting emissions will make little difference if temperatures rise slowly and by only a few degrees (to Jacoby, such limits are an insurance policy against the worst outcomes).

The reply of compensationists is not that nature can heal itself but that Simonian ingenuity will let us increase agricultural and industrial output while reducing greenhouse gases and even restoring the environment. The classic statement of this position is a 1996 essay by Rockefeller University scholar Jesse H. Ausubel. Ausubel cited encouraging long-term trends toward more-durable products (thanks to the use of stronger and lighter materials) and more efficient recycling. Those trends toward "dematerialization" and new energy technology could reduce emissions while letting the world return more agricultural land to its natural state; for example, with wood no longer a popular fuel, the forests of the northeastern United States have grown back in the past century.

What would Einstein say about these two models of the future? On the one hand, he believed in technological adaptability. He came from a family of electrical equipment entrepreneurs (though ultimately unsuccessful ones), and he even coinvented a new cooling system after reading about refrigerator explosions in Berlin. On the other, he did not try to foresee trends as von Neumann did. Einstein had little to say about the future precisely because he did not see it as being determined by scientists or engineers, or even by political constitutions. "Everything depends," he replied to a correspondent's questionnaire in 1948, "on the moral and political quality of the citizen."

There's another question about the future, an ethical and aesthetic rather than a predictive one, and it concerns the cultural ties between past, present, and future. The choice is between affirmation and balance—that is to say, between a material and artistic culture that reflects and even anticipates change, using new forms and materials, and one that cushions the psychological and spiritual shocks of change by adapting familiar and reassuring themes. Should we espouse—affirm—values that are tied to the latest scientific trends and our expectations of future progress? The Italian futurist movement of the early 20th century called for the destruction of the West's ancient culture to prepare for a new hard-edged scientific and technological age. Adherents of movements such as Extropy (founded in 1988 and devoted to unlimited progress through advanced science and technology) believe it is our duty to develop ourselves physically and culturally into a superior version of humanity.

But others draw the opposite conclusion. Precisely because the pace of change is so rapid, they say, we should turn to the reassurance provided by established and harmonious forms. The art, music, and architecture of the future, and especially of the present, should not be about DNA, nanotubes, or quantum computing. Appealing to nature and spirituality, our cultural lives should soften the shocks of innovation. Within traditional Eastern and Western faiths, and especially in New Age movements, many technical professionals find a counterbalance to the often-disruptive realities of technology. Unlike extrapolation and compensation, which are styles of predicting change, affirmation and balance are responses to ongoing or expected change. They're not verifiable by experience; they're the conditions that help us deal with experience.

Tacitly at least, Einstein was on the side of balance. Immersed in mathematics and science, he showed little interest in the advanced literary and artistic trends that sought to evoke relativity. In music and literature, Einstein remained true to the humanism he had absorbed in his youth. He once called classical music "the driving force" of his intuition. According to Robert Schulmann, former director of the Einstein Papers project, Einstein's musical tastes were grounded in Bach and Mozart; Beethoven was too passionately emotional for him. He did admire and befriend one contemporary experimental composer, the Czech Bohuslav Martinů, but Martinů was a loner among the avant-garde. How would Einstein have reacted to more-recent music invoking his ideas? Philip Glass and Robert Wilson's opera *Einstein on the Beach*, for example, which opened more than two decades after Einstein's death, would probably have bewildered him, with its cascade of multimedia images and its syllabic chanting. And he showed little interest in the ferment in painting and sculpture that characterized the interwar and post–World War II years.

It's probably in our visual surroundings, in architecture and design, rather than in music and art, though, that the tension between affirmation and balance is most apparent, especially in Einstein's case. Men and women may not often reflect on religious or philosophical principles, but they cannot avoid buildings, furnishings, and everyday objects. In design, too, Einstein resisted the harsh and hard-edged styles often associated with

future orientation. He did praise the architect Erich Mendelsohn's Einstein Tower, a multistory astronomical observatory in Potsdam named in his honor, but he praised it for its curving, "organic" shape, which did not reflect the architectural avant-garde of the day.

Einstein never worked in his namesake building. He was happy in the conservative setting of Princeton. Fuld Hall, the main building of the Institute for Advanced Study, completed in 1939, is standard institutional Federal. After Einstein's death in 1955, the Institute hired the Hungarian-born modernist Marcel Breuer to design a housing complex for visiting academics, and one of the streets was named in Einstein's honor. But the great physicist had never shown an interest in Breuer's high modernism. Einstein believed that his work was to seek timeless truths, not set a trend; he did not care if the science of the future was done in a building of the past. But not every pioneer of advanced thinking has been as content as Einstein to work in familiar and comfortable surroundings. Charles Simonyi, for example, who made a fortune as master designer of Microsoft's application software, built an expansive, architecturally innovative Seattle-area house that plainly reflects the ideas of an aesthetic and scientific avant-garde.

Both attitudes toward the aesthetic future—embracing novelty and buffering it—have played out since the 1920s, when technological modernism reached its high point. In 1927, the city of Stuttgart sponsored a residential development of the future on a scenic hilltop above the city. Some of Europe's leading modernist architects, including Ludwig Mies van der Rohe and Le Corbusier, built the extensive complex. But the workers who were to be residents did not want picture windows and tubular furniture. They did not care about the factory of the future. They simply wanted as little as possible to remind them of their industrial workplaces of the present. Rejecting modernist idealism, they preferred the upholstery and knickknacks of the petite bourgeoisie. The complex was soon rented out to bourgeois intellectuals of Weimar Stuttgart, who were delighted to live in a community of tomorrow.

Today, little of the old industrial working class remains in the West. Most of us are now what the late management guru Peter Drucker called knowledge workers. There was a high-tech furnishings movement in the early 1980s, but today's professionals, by and large, are not interested in personal surroundings that evoke the Web. I saw this clearly in 2003 when I visited the "house of the future" on the Microsoft campus in Redmond, Washington. The house was actually a suite of rooms illustrating applications of new network technology. There was nothing overtly high-tech about the rooms; furnishings were warm, with lots of dark wood. The futurist component was the networked appliances, which could, for example, play back telephone messages with the callers' pictures or display a profile of someone ringing the doorbell. In this setting, technology represented security and support for an affluent way of life rather than a framework for living. Who wants to be challenged aesthetically at home after a hard day of symbolic problem-solving at the office?

Our techniques of forecasting the future (material extrapolation and compensation) and our cultural strategies for coping with it (affirmation and balance) have something in common: They're both expressions of expectations that shape the real future. In 1948, the sociologist Robert K. Merton coined the phrase *self-fulfilling prophecy*, and we're still working on many of the predictions of that era. We're also reverting to the familiar in the face of change, buying sentimental realist paintings and reproduction antiques. The future is indeed a foreign country, but it's also a place that we ourselves design, usually inadvertently. In the end, the interplay of expectation and behavior is what *creates* the future.

Fortunately, there are times when optimism about tomorrow produces works that continue to inspire hope for a better future. Perhaps the most visible of these works today are certain of the great laboratories built during the science boom of the late 1950s to the early 1970s. At the Salk Institute for Biological Studies (1965) in San Diego, architect Louis I. Kahn combined special steel with a type of concrete that had originated in ancient Rome; he used natural light throughout and channeled it with innovative reflectors to below-ground levels. Nine years later, Alan H. Rider conceived the elegant administration building of the Fermilab National Accelerator (1974) in Batavia, Illinois, with curved towers that created a space inspired by the cathedral of Beauvais. A herd of bison roams the grounds, which were designed as a sanctuary for native plants and animals.

The two buildings combine exuberant hope for the future with profound respect for human and natural heritage. In such great material visions as these buildings, extrapolation and compensation, affirmation and balance, coexist magnificently. They make us temporal immigrants feel immediately at home. ■