The Fading Joys of Research

The thrill of discovery is now, as it was for Einstein, the essence of science. But for today's researchers, the excitement must compete with the increasing frustrations of big science.

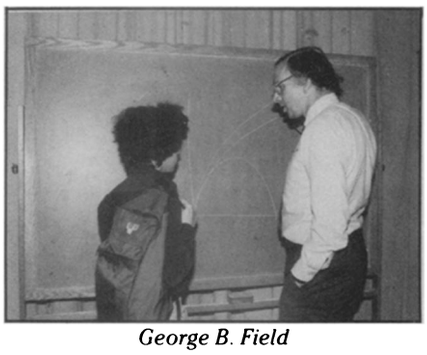
BY SUSAN WEST

❧ *"To the sphere of religion belongs the faith that the regulations valid for the world of existence are rational, that it is comprehensible to reason. I cannot conceive of a genuine scientist without that profound faith. The situation may be expressed by an image: Science without religion is lame, religion without science is blind."*

Einstein said it himself — science is something of a religion. If so, then Einstein, though he would wince at the analogy, was a high priest of that faith. The shock waves of his theories rattled the philosophical as well as the physical world; the man himself became a symbol of science. His words were dutifully preserved. His papers, letters, even his pipe — like religious relics — are enshrined for this 100th anniversary of his birth. Once he even remarked that he was being made into a Jewish saint.

Last week, in that temple of science called the Smithsonian Institution, a group of latter-day priests of science gathered to complete the canonization. But the eight disciples — four of them Nobel laureates — came not so much to worship Einstein as to witness their faith in the spirit of science he personified and expressed so eloquently. As might be expected of members of a common faith, their comments, under the rubric "The Joys of Research," often echoed Einstein's own words.

❧ *"Outside events capable of determining the direction of a person's thoughts and actions probably occur in everyone's life. But with most people such events have no effect. As for me, when I was a little boy, my father showed me a small compass, and the enormous impression that it made on me certainly played a role in my life."*



George B. Field

For George B. Field, it was a slide rule that made the enormous impression. As a boy, Field told the audience at the two-day symposium, he was caught by the concept of a light-year as distance measured in terms of time. His father gave him a slide rule, and with it he calculated the number of miles in a light-year. He proudly reported his answer — which he says is six trillion miles — to his teacher. The teacher, however, informed Field that he was mistaken. A light-year, he said, was only a measure of time, not distance. "Well," said Field, "I knew better, but I just bit my lip and remained silent." He grew up to be a theoretical astrophysicist and director of the Harvard-Smithsonian Center for Astrophysics.

❧ *"Science is a wonderful thing if one does not have to earn one's living at it. One should earn one's living by work of which one is sure one is capable. Only when we do not have to be accountable to anybody can we find joy in scientific endeavor."*

"It is, in fact, nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry."

Though he was trained as a physicist, Einstein was a patent clerk when he published the Special Theory of Relativity. He often encouraged others to avoid the "publish or perish" syndrome of academe by taking a job that would interfere little with their scientific pursuits. By his own admission, he found school stifling rather than stimulating.

He would have been pleased with Julius Axelrod. Like Einstein, Axelrod came in by the back door — in spite of the system, said one participant.

"Successful scientists are generally recognized early, they go to the best schools, they train under the very best people, they publish early and are recognized," said Axelrod, the 1970 Nobel Prize winner in physiology or medicine. "None of this happened to me."

Born in a ghetto of New York, he went to public high school and, because it was free, to City College of New York. He couldn't get into medical school. He couldn't afford graduate school. He took a $25-a-month job in a food-testing laboratory and worked there for ten years. Only

Anna J. Harrison (left) and Julius Axelrod

at the age of 42 (because he wanted a promotion, he says) did he get a Ph.D. By that time, he had been at the National Institutes of Health for several years (he is now at the National Institute of Mental Health) and had already begun some of the work that led to the Nobel Prize. Einstein would also have liked Axelrod's approach to science: "It doesn't require lots of training and a great mind. It's a matter of thinking about [a problem]. And thinking about it in new ways."

❧ *"[T]he years of anxious searching in the dark, with their intense longing, their alterations of confidence and exhaustion, and the final emergence into the light — only those who have themselves experienced it can understand that."*

"The scientific theorist is not to be envied. For Nature, or more precisely experiment, is an inexorable and not very friendly judge of his work. It never says 'Yes' to a theory. In the most favorable cases it says 'Maybe,' and in the majority of cases simply 'No.'"

But nature said "Yes" (or else a quite positive "Maybe") to Einstein and it caused a revolution. Nature also gave the nod to Ernst Mayr and to J. Tuzo Wilson, causing substantial upheavals in their fields as well.

Mayr, an evolutionary biologist at Harvard University, began to study one of the major problems in evolution — how species diversify. Initially he concluded that simple geographic variation was responsible for the development of new species. Most evolutionists were satisfied with the explanation, but after a while

Mayr began to itch. Something wasn't quite right.

On expeditions to New Guinea and the Solomon Islands, he noted that only a single species of bird, for instance, occupies the vastly varying climatic and geographic environments of New Guinea. A markedly different species occupies each island, even though the islands do not cover nearly so wide a range of habitats. Mayr settled on a much more genetic explanation of species diversification: A new species will develop when a founder population, having limited genetic variability, is geographically isolated from mixing with the larger gene pool. His theory, now the basis for understanding speciation, was not accepted for more than a decade. "This is one of the joys of research: the final acceptance of the process of speciation," he said. "[T]he joy of research is not the accumulation of facts but the search for the understanding of the world and the development of laws and principles that tie together facts and explain their meaning. The discovery of a new law gives infinitely more satisfaction

Ernst Mayr

J. Tuzo Wilson

than the discovery of a new fact."

The scientific revolution J. Tuzo Wilson abetted was no less powerful than the one Einstein instigated. When Wilson, a geophysicist and director of the Ontario Science Center, began his career, geology consisted of tramping around with a sextant and picking up rocks. It was "something like postage stamp collecting," he said. Theorizing about geologic processes was near-heresy and largely unsuccessful. The crucial concept of the earth as a mobile body had not yet been perceived — it was like building a car before the discovery of the wheel. But Wilson, like Einstein and Axelrod, was unorthodox. He had, quite literally, a bird's-eye view of the world. He was among the first scientists to use an airplane as a research tool, and his ideas of the world were shaped by aerial photography, he says.

Because of that vantage point, Wilson, at age 50, converted to the theory of continental drift that was substantially proposed in the early 1900s by Alfred Wegener. Wilson became a prime mover for the acceptance of the theory and, with others, refined the accompanying principle of plate tectonics. Among Wilson's individual contributions were the proposal that the Atlantic had split, closed and reopened at least once, and the still-debated hotspot theory of the formation of volcanic island chains. His paper proposing the assembly line formation of the Hawaiian islands by the movement of the Pacific plate over a stationary plume of magma was turned down by the venerable JOURNAL OF GEOPHYSICAL RESEARCH on the grounds that it "contained no new data, had no mathematics in it and disagreed with current views." The final, embattled acceptance of a restless earth recharged the earth sciences.

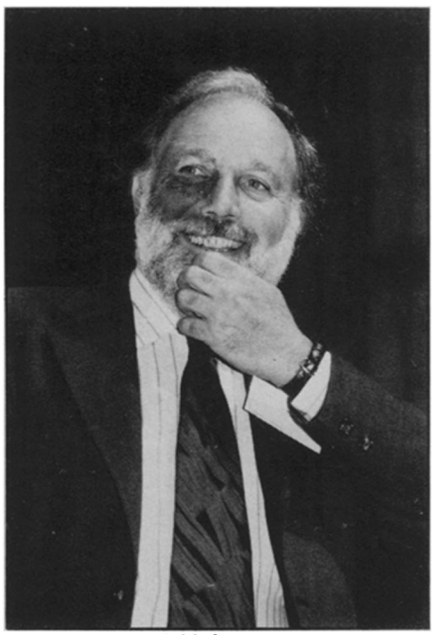
"The greatest joy that one can get in scientific research," says Wilson, "is to occasionally think that one might have had for a short time an original idea that one feels to be correct. It doesn't really matter if it gets published or accepted or not as long as you think you were correct."

❧ ***"My scientific work is motivated by an irresistible longing to understand the secrets of nature and by no other feelings."***

"Man seeks to form for himself in whatever manner is suitable for him, a simplified and lucid image of the world, and so to overcome the world of experience by striving to replace it to some extent by this image. This is what the painter does, and the poet, the speculative philosopher, the natural scientist, each in his own way."

Perhaps in this sense, more than any other, Einstein shared the rostrum at this gathering. The exercise of one's particular talents and the "power of creation" that links artists and scientists is science's special attraction, says I. M. Singer, mathematician at the Massachusetts Institute of Technology. "There is a double joy involved. The first is just the joy of working hard, struggling and finally seeing through some result," he says. "After that, there is the joy of knowing that this might and probably will have a very serious application in another field."

For two-time Nobel Prize winner Linus Pauling, science is constant change.



I. M. Singer

Linus and Ava Helen Pauling

Photos: Richard Hofmeister/Smithsonian Institution

"There are many discoveries that still surprise me," says the 78-year-old chemist. "Perhaps in the next 10, 20, or 30 years I will still enjoy myself by reading about, learning about and participating in new aspects of nature."

But the spirit of Einstein spoke loudest when Rosalyn S. Yalow said, "I'm a scientist and an investigator because at this stage, even after the Nobel Prize, the biggest thrill is to go to my laboratory and hope that that day I will know something that nobody ever knew before. There are very few days when that happens, but the dream is still there."

Rosalyn S. Yalow

❧ ***"One thing I have learned in long life: That all our science, measured against reality, is primitive and childlike – and yet it is the most precious thing we have."***

But that precious thing may be endangered; the temple may be crumbling. Einstein, a man who worried that conventional educational methods "strangled the holy curiosity" and who deplored the intrusion of government into science, would be appalled by the current state of science.

Science education, as moderator Anna J. Harrison of the American Chemical Society observed, rewards those students who are quick and clever, rather than those who are innovative and creative. This crop of would-be researchers is finding that only those who are "brilliant or very, very lucky" will get into graduate school, said a member of the audience, a Washington area high school student. And, the student said, though there may be joy in research, there is certainly "no joy in getting there." Axelrod, without a Ph.D. until the age of 42, would never have left that food-testing laboratory. Einstein's own tangles with conventional education are legendary.

There is another distressing trend in science. Howard M. Temin, himself a product of the post-World War II educational system ("I went to an excellent high school, excellent small college, to one of the premier graduate schools ... immediately got a good research position and have been there ever since carrying out the same research."), chose to concentrate not on the joys of research but on the increasing frustrations. The internal frustrations of science — of not seeing an idea, of not receiving proper credit, of solving a problem only to find that the answer is insignificant — complement the satisfactions, he said. But the external frustrations — the "unbalanced and intrusive" regulation, the grantsmanship and the "erratic appreciation of research and its application" — may doom science as Einstein knew it, says Temin. Temin, professor of oncology at the University of Wisconsin in Madison and Nobel Prize winner for the discovery of RNA transcriptase, finds his laboratory time and his effectiveness eroded by what he sees as senseless and arbitrary regulations that "somewhere may simplify something but [have] no real effect where we are."

Howard M. Temin

"My lab — one of the premier cancer research labs in the world — actually was cited for unsafe handling of chemicals by the state government. ... We are now spending a half million dollars of your money to correct these problems at great disruption.... I have to, every month, sign in triplicate that all of the people on my grant have worked at 100 percent effort that month and...I have to send [copies to the other people on my grant] so that they can sign that their people have and so that I can sign that they have signed.... Every month I must sign a yellow piece of paper that says 70 percent of my support comes from non-federal money...when I have no way of knowing that in fact that has happened."

The spirit of science is being thwarted, he says, by the grantsmanship games he and his colleagues must play in order to fund their research. "I see pervasive insecurity which stems from concern about how each set of experiments is going to look to grant reviewing committees. ... [They are] hoping that their results will have immediate significance so they can be sold more easily."

Still worse is a lack of appreciation of the results of research. For example, he says, there is "no question about what is the major preventable cause of human cancer deaths" — the cigarette — yet the results are ignored. Specifically, he says, the government could do far more by educating the public and by imposing a "prohibitive tax" on high "tar" and nicotine cigarettes.

On the 100th birthday of a man who captured the freedom and independence of science, it is appropriate to ask what the future of that way of life will be.

"What we see," says Temin, "is a trend, a very ominous trend...our effectiveness as scientists and the effectiveness of our science is being curtailed. My hope is that the students, and even the children born this year of Einstein's centennial, will have the same opportunities to do essentially free science that we had. My fear is that they will not." □