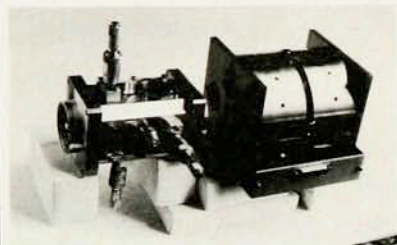


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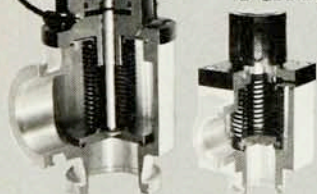


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In conclusion, I urge my critics to remember that the universe is, as the biologist J.B.S. Haldane said, not only queerer than we suppose but queerer than we *can* suppose. There is no illusion more dangerous than the belief that the progress of science is predictable. If you look for nature's secrets in only one direction, you are likely to miss the most important secrets—those that you did not have enough imagination to predict.

FREEMAN DYSON

*Institute for Advanced Study
Princeton, New Jersey*

4/88

SSC: Opinion Splitter

One of the many considerations in a decision about the proposed Superconducting Super Collider project should be the extent to which physicists favor this project. The physics community in the United States is well represented by the membership of The American Physical Society. Unfortunately this society has no mechanism for polling its membership on an issue.

I therefore undertook such a poll myself. Because I had to rely on my own personal resources, the sample had to be modest. It was selected on the basis of a pattern of location in the directory of The American Physical Society. The questionnaire was sent to 247 names.

The letter included a brief explanation of the poll, a slip to be returned with the vote, and an addressed but unstamped return envelope. The slip to be returned contained the following text:

"Return this portion in the attached addressed envelope.

"In view of the circumstances as I perceive them, I am/am not (cross out one) in favor of the construction of the Superconducting Super Collider as projected in the present plans submitted to Congress."

The forging of ballots was guarded against in two ways. The return envelope was addressed with a rubber stamp, the forging of which would be difficult. In addition, the return slip was embossed with a personal "ex libris" embosser, the forging of which would also be difficult. A cursory inspection of the returns indicated no cause for anxiety about forging.

By the deadline of 5 February 1988 (six weeks after the original letters were mailed), 26 original letters had been returned to me as undeliverable and unforwardable. Thus 221 ballots presumably reached the addressees.

Of these, an astounding 109 re-

sponded. Such a 49% return, with only one mailing and no return-paid provisions, appears to indicate that the issue is of interest to physicists.

Of the 109 responses, 2 were illegal in that the addressed return envelope did not accompany the ballot, in spite of the underlined request. Of the 107 valid ballots, 59 (55%) were in favor of construction, 45 (42%) were opposed and 3 (3%) were undecided.

Of those 107 ballots, 87 came with US postmarks and 20 with foreign postmarks, the latter presumably from foreign members of The American Physical Society.

Among the 87 domestic returns, 46 (53%) were in favor of construction, 39 (45%) against and 2 (2%) undecided. Correspondingly, among the foreign respondents, 13 (65%) were in favor, 6 (30%) against and 1 (5%) undecided.

Considering the modest size of the sample, one can conclude that the community of physicists, as represented by the membership of The American Physical Society, is about evenly divided on the issue of the construction of the SSC.

Insofar as the SSC issue affects all scientists in the United States, it would be of interest also to have a similar poll of scientists outside physics.

MICHAEL J. MORAVCSIK
*University of Oregon
Eugene, Oregon*

4/88

Remembering Richard Feynman

Thank you for publishing Richard Feynman's article on his "inside view of the Challenger inquiry" (February, page 26) when you did. I realize that it was only by a quirk of fate that its appearance coincided so closely with his passing. Still, you could not possibly have printed a better epitaph if you had tried. The article embodied the essence of Feynman's character that made him a physicist's physicist. He is sorely missed.

ROBERT J. BARKER
*Air Force Office of Scientific Research
Washington, DC*

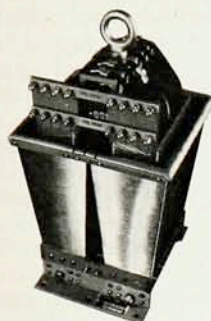
2/88

What Washington, DC, needs is for an army of Feynmans to descend and start investigating everything in sight. What Richard Feynman had to say about NASA could be said about a lot of organizations, including the many faltering private-sector companies in the US that once were global leaders. When the leadership starts listening only to those who tell it what it wants to hear, decline is

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EDITED BY A.G.W. CAMERON,

Harvard-Smithsonian Center for Astrophysics

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inevitable and rarely reversible. This is the theme of Mark Twain's *A Connecticut Yankee in King Arthur's Court*.

News of Feynman's death a few days ago saddened me very much. The world has so few prominent people with so much candor that losing even one hurts.

FOSTER MORRISON
*Turtle Hollow Associates
Gaithersburg, Maryland*

3/88

Like every other member of the physics community, I was saddened to learn of the untimely death of Richard Feynman. Seeing his picture on the cover of the February issue of *PHYSICS TODAY* brought to mind a memory of Feynman that I thought your readers might enjoy sharing. When I was a graduate student at Yale, I attended a lecture he gave at an American Physical Society meeting in New York. The subject was quantization of the gravitational field. Feynman was emphasizing the weakness of the gravitational force compared with the other fundamental forces of nature. In his characteristically forceful manner, he asserted that "the gravitational force is weak; in fact it's damned weak!" At this juncture, a loudspeaker embedded in the ceiling of the meeting room came loose and fell to the floor. Without missing a beat, Feynman said, "Weak, but not negligible."

I greatly admired his presence of mind and quick wit. When I returned to Yale, I described the event to my thesis professor, Gregory Breit. Breit, who was not renowned for his sense of humor, shook his head at my story, and commented, "Professor Feynman allows his personality to intrude upon the physics." My own opinion is that physics was greatly enriched by Feynman's personality and by his many contributions to science and education.

ALEXANDER J. GLASS
Berkeley, California

4/88

In the summer of 1972 I was a graduate student in physics at MIT. As a good break from the sweatshop my friend Bill Wegener and I decided to buy a van and travel around the country, getting a good dose of Americana and all that. It was a typical 70's thing to do, and we were typical 70's kids. Well, not quite. Along with a bunch of rice and sprouts, our guitars and Bill's flute, we brought a small library of "cultural" physics and math books. These were mostly relativity, differential geometry and particle physics books. Plenty enough to impress any wayward hippies we

might find on the trail. The one exception to this morass of high-end physics lit were two copies of *The Feynman Lectures*—one each for Bill and myself so that we could each write notes and comments in the margins.

To physics students everywhere Richard Feynman was a legend, a spirit of science that seemingly embodied the best of all human qualities—compassion and warmth, a strong yearning to share knowledge and an insatiable, almost childlike curiosity about the world. The picture on page 3 of *The Feynman Lectures* says it in a nutshell. There's Feynman, the Nobel laureate, merrily playing his bongos, as if to say: "Learning is fun. Come join with me and together we'll explore the wondrous secrets of nature."

During our trek westward we religiously read *The Feynman Lectures*, trying our hardest to glean every bit of knowledge from the pages of those three red books. Our admiration for Feynman increased with each passing mile. So did our curiosity about Feynman the bongo player. Maybe he would invite us over to jam? After all, we were pretty fair musicians—and were were physics students living out of a van. Feynman would love us! Finally, we crossed into California and crashed at some friends of a friend's house in Laguna. I decided to try my luck. I called Feynman's office at Caltech. As soon as I dialed the number I got cold feet. My hands started sweating. Bill didn't want anything to do with this idea. *Could we get kicked out of grad school for this?* My heart was thumping with that frantic, heavy beat that accompanies massive infusion of adrenalin into the blood. I wasn't even this nervous when I called Barbara Robbins up for a date back in high school—and she had claimed to know John Lennon! Feynman's secretary answered. I stammered a brief introduction and asked if Professor Feynman was there. I said that my friend and I were physics students from MIT (she had vaguely heard of it) and that we had driven cross-country in this old Dodge van and we wanted to invite Professor Feynman to play his bongos with us. There was a silence for a few seconds, then Feynman's secretary said that she was sorry, but Professor Feynman was out of town for a while. However, if we were in Pasadena again sometime, she was sure that he would enjoy meeting us. Then she hung up. That was it, I thought. I would never get to meet this incredible person. The physics gods had spoken.



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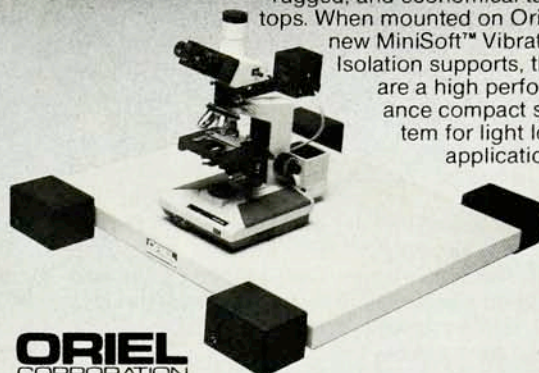
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PHYSICS TODAY

MAY 1988

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What a strange twist of fate events can take. I've been a space physicist at Caltech's Jet Propulsion Lab for over ten years and I'd sort of forgotten about 1972. Among other things, I've worked with the public affairs office to host visiting dignitaries during the various Voyager encounters with Jupiter, Saturn and Uranus. This is not part of the job description, but it's a nice perk. You get to meet all sorts of interesting people and JPL feeds you very expensive food for your trouble. On Saturday, 25 January 1986, three days before the Challenger blew up, JPL hosted the Voyager Uranus Encounter gala. I was stationed in the Gallery—an area that overlooks a science-fiction-like arena of mission operations activities and some wonderful big-screen displays of planetary images coming in from Voyager.

About 6 pm all the guests had left and I was cleaning up the area—mostly stuffing leftover fancy food into a giant plastic bag to bring to my friends in the science operations area one floor above. After ten hours I was tired, my feet ached from standing most of the time and I wanted to get home. Suddenly I heard voices coming up the stairs. I figured maybe it was some guest—or worse yet, Lou Allen, JPL's director. Whoever it was, I couldn't let them see me absconding with the food. But where do you hide an overstuffed Hefty Bag? I turned around to meet my fate and my eyes focused in the dim light on Dick Feynman himself, escorted by his sister Joan, a physicist in our section.

In my best adult voice I greeted them and asked if I could help them—or if they would like any food, since I just happened to have this big plastic bag full of all sorts of rich people's edibles. Joan said that they were just browsing around, looking at Voyager stuff. I offered to explain anything that they might want to know, and before I knew it I was involved in a multiplexed conversation with Dick on everything from Uranus pictures (how did the spacecraft do motion compensation?) to institutional parking scams [my 1979 JPL parking ticket record versus his Olympic-medal-winning (I believe this may even be a demonstration sport in Seoul this year) Los Alamos parking extravaganzas]. We also covered vast areas of physics as well as various and sundry stories about our respective youths. He seemed definitely impressed that I had read his book and knew so much about his life (I didn't tell him then, but I had read it twice and sent copies to several relatives and friends as

well). The evening ended about two hours later when I brought Dick and Joan over to the science operations area to say hello to the MIT plasma team. By then my tired mind and aching feet had returned, and it was time to go.

Three days later the Challenger exploded and soon all the world got to know the man whom I had experienced in those two incredible hours. Feynman was a true kindred spirit, and his brief influence on me, as on so many others, will indelibly mark itself.

Two weeks ago, on the local evening news, I heard about his death. I cried that night, as I am sure many others did in Pasadena and around the world. The following day, on Caltech's Millikan Library tower, a banner reading, "WE LOVE YOU DICK!!" was hung across the top floors by Caltech students.

Wherever you are, Dick, I hope you have your bongos, 'cause we're going to have one hell of a jam session up there one of these days!

ROBERT SHERMAN WOLFF

Jet Propulsion Laboratory

California Institute of Technology

3/88

Pasadena, California

Challenger's British Ancestor

We read with great interest Richard Feynman's February article (page 26) describing his experiences while serving on the Rogers Commission investigation into the Challenger accident. The insights that this remarkable man has provided into the implications of the Challenger disaster are pertinent whenever large governmental organizations engage in the advancement of technology. In particular, we were most taken by striking similarities between Feynman's descriptions of the failings in NASA's shuttle program and the history of another high-technology development program: that of rigid airships in England.

The development of rigid airships in Britain culminated with the construction and testing of the R100 and R101 airships during the period 1925–30. Those two airships were built to the same government-issued specifications, but one (the R100) was made by a private firm, while the other was undertaken by the Air Ministry organization at Cardington. In effect it was a competition between government and private industry. The R100 was successfully built and tested. The R101 was beset by both technical and political difficulties,

and crashed with great loss of life during its first long-distance flight. The various technical difficulties suffered by the R101 have been described by Lord Ventry and Eugène M. Kolesnik.¹ Among these difficulties was an inability to meet the specification for lift, which was solved by cutting the airship in half and inserting an extra hydrogen gas bag. Perhaps the most serious problem came about from the method of fastening the outer cover to the structural framework, which relied on "tapes fixed to the interior ... with a rubber solution" that "reacted with the dope on the cover to make it very friable."¹ (It seems that the Challenger was not the first large technological undertaking to be compromised by a failure to understand a common material like rubber.) The program was further hampered by scheduling pressures related to the desire of Lord Thompson, the Secretary of State for Air, to use the R101 for an important official visit to India. Important flight tests were deferred because of this schedule pressure. Finally the "R101 slipped the mast ... at 6:36 pm on 4 October 1930. Many of those responsible for the ship were concerned about her state of airworthiness, and yet a temporary Certificate of Airworthiness was handed to her captain just before the flight began."¹ The R101 crashed in France during that flight, with the loss of 48 out of a crew of 54.

Nevil Shute, the novelist, worked on the R100 as an aircraft design engineer. In his autobiography, written in 1953, some 25 years after his airship experiences, Shute assesses the technical and, with great astuteness, the human failings leading to the R101 disaster. His description of the pressures on the Cardington design staff is especially interesting. The Air Ministry press department's demands for favorable stories justifying the expenditure of public money ultimately had the effect that "the Cardington designers found themselves hemmed in behind a palisade of their own published statements which could not be broken through without some personal and public discredit, till one course only was left open to them, a course they never would have taken had they been free men, a course which was to lead to tragedy and death."² These views of Shute are incredibly similar to those expressed in the closing paragraphs of Feynman's article about another technical accident decades later.

We see two major points to be learned, which can be applied to a wide spectrum of endeavors. The first is the necessity for a well-defined and