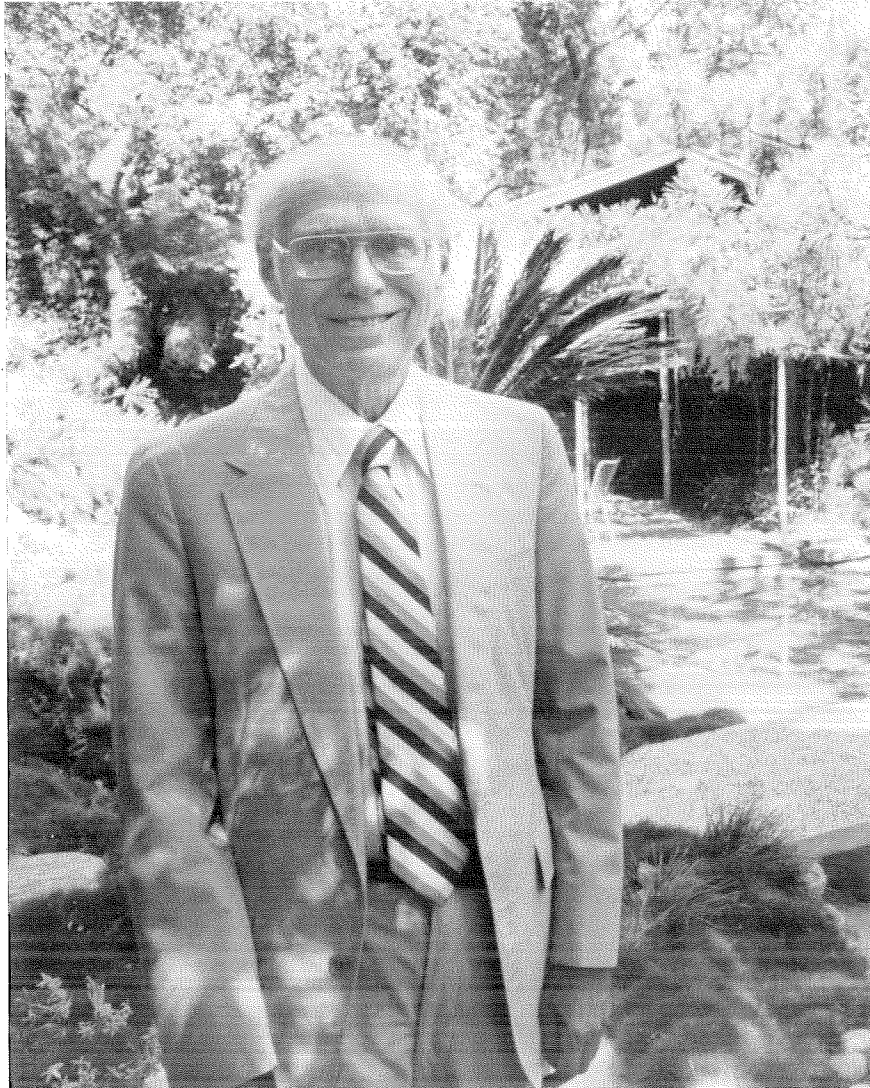


An Interview with John R. Pierce

by Paul J. Nahin



AT THE age of 71, when most men have been comfortably retired for years, John Robinson Pierce is energetically into his third career. Retired since 1980 from his second career at Caltech (he is now professor emeritus of engineering), Pierce is chief technologist at the Jet Propulsion Laboratory, operated by Caltech for NASA in Pasadena. To this role Pierce brings decades of experience as both a research engineer and corporate executive at The Bell Telephone Laboratories.

Born in Des Moines, Iowa, in 1910, Pierce graduated from Caltech in 1933 with a degree in electrical engineering, and stayed on to take a master's in 1934 and a doctorate in 1936 in the same field. From then until his first retirement in 1971, he was employed at Bell Labs, finishing with the title of executive director of research, Communications Sciences Division. Even while busy at this demanding job, however, he occasionally found time to publish science fiction stories. The first appeared in a 1930 issue of *Science Wonder Stories*, and nearly two dozen more followed over the years (many at a time when to write speculative fiction wasn't nearly as "respectable" for scientists as it is today).

Pierce's skill with words isn't limited to fiction. He has written a large number of scholarly papers and books, mostly in the broad area of electronic communication devices and systems, and has made many important contributions to this field. His 1975 IEEE [Institute of Electrical and Electronic Engineers] Medal of Honor was awarded in part, for example, in recognition of his many innovative ideas in the design of high gain, large bandwidth traveling wave tubes, which in turn helped to make satellite communications practical.

His 1950 book, *Traveling Wave Tubes*, sits on the shelves of thousands of microwave engineers, worldwide. A more recent one, *Symbols, Signals, and Noise*, an introduction to information theory and electronic communications for laymen, is considered a classic of its kind. He is co-author of a new work, a textbook called *Introduction to Communication Science and Systems*, released last year by Plenum Press. It is based on his undergraduate teaching experiences at Caltech. Pierce is now at work on yet another book (with the working title *Science and Musical Sounds*) that reflects his long-time interest in the generation of synthetic sounds by digital computers.

During a recent visit with Pierce at his

Japanese-style home in Pasadena (complete with reflecting pool and waterfall), I heard him hold forth on a wide range of serious and speculative topics. One of the questions I asked him was how he came to be an electrical engineer rather than, say, a physicist or a mathematician.

Pierce: Originally, when I went to Caltech, the only technical person I knew was the father of a friend of mine who was a chemical engineer. So I thought I would be a chemist or a chemical engineer.

Freshman chemistry cured me of that. It was disastrous, especially in the laboratory. And then, since I was building and flying gliders, I thought I'd be an aeronautical engineer. But in drafting my lettering was poor, and moreover we drew endless beams with rivets. So I looked for some sort of engineering that wasn't full of rivets. I became an electrical engineer.

I didn't become a physicist because in the catalog there was a language requirement that apparently would have debarred me. I found electrical engineering, which was largely power engineering in those days, not to my liking. But there was one professor on the faculty, name of Stuart Mackeown, whose field was electronics. I gravitated in that direction, taught a radio engineering course out of Terman's book when I was a graduate student, and Mackeown got me a job at Bell Laboratories.

My electrical engineering courses were about rotating machinery. The only rotating machinery I ever saw at the Bell Laboratories was the fan in my office. I was put to work on vacuum tubes, of which I knew nothing. From there on chance took over. I didn't find electrical engineering narrow and dull. It just went from one thing to another.

Nahin: Did science fiction play a role in your decision to become an engineer?

Pierce: Oh, yes, I'm sure it did! It excited me. I remember that after the first year of *Amazing Stories* I could look at the annual index and remember what each story was about. I thought that this was science and technology, in those days. I now realize it was really a sort of fantasy. It bears the same relation to the world of technology and science that legends of the saints do to the Christian religion.

But it's very inspirational. I have known so many people in whose lives science fiction played an important part. Detlev Bronk, who was president of the National Academy of Sciences for many

years, and also of Rockefeller University. Also Lloyd Berkner, the radio pioneer and Antarctic explorer.

I found that they had been inspired by [Hugo] Gernsback, both by his science fiction and by his Electro-Importing Company that sold them radio parts when they were young. Indeed, at my suggestion, in Gernsback's later days, Detlev Bronk called Gernsback and told him of this, which greatly pleased Gernsback.

Nahin: The Cornell pop astronomer, writer, and newly emergent TV star, Carl Sagan, has said that science fiction does a good job of attracting youngsters to science, but not in sustaining that attraction. Do you have any reply to that?

Pierce: I think that an attraction is necessary. But a sustained interest in science or technology or engineering requires something of the individual. That he *do* something, rather than just passively read. Many individuals are disinclined or incapable of doing anything. It's often remarked that children show a great deal of curiosity and adults don't — most adults. The popular explanation of this is that something is done to the children to kill their curiosity.

I think it may be that some children are

tical, it is worthwhile to understand Maxwell's equations simply for the good of his soul." Many other mathematicians and scientists who have also been struck with the elegant simplicity and beauty of the way Nature works have speculated it just couldn't all be an accident. That is, the universe has to be the handiwork of a higher spirit, a "God." Do you go that far?

Pierce: It's wonderful to admire Maxwell's equations, but a little presumptuous to bring God into it. Mathematics is just a game that people have made up and play. Unlike other games, say chess, it happens to be one that often can be related to the physical world. That's very natural, of course, because mathematics had its origins in very practical things, like building and surveying.

Not all mathematics is like that today, however, Modern mathematicians just love games with abstract rules that live all by themselves. That way they don't have to be physicists too!

Nahin: In his book, *The Character of Physical Law*, Caltech's Nobel prize-winning physicist Richard Feynman says he believes that C. P. Snow's "two cultures" are separated into people who

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curious and find curiosity rewarding because they're capable of learning and finding something out. So they continue to be curious. Other children are curious, but never carry through the curiosity to resolving anything, and so they don't find curiosity rewarding.

It is the same, I think, with reading science fiction. It inspires some people to go and find out what science really is. Just as legends of the lives of the saints have probably inspired some people to become truly religious. For others it's just amusement and they pass on to something else.

Nahin: You've mentioned religion several times. To pursue that just a bit, in your book *Electrons, Waves and Messages*, you wrote, "To anyone who is motivated by anything beyond the most narrowly prac-

have, and those who haven't, experienced an understanding of mathematics well enough to appreciate the machinery of Nature. Do you feel there is a widening gulf between those who understand technology and those who don't?

Pierce: Yes, and it may be because technology is getting more complicated.

Nahin: Do you think people are more self-indulgent now?

Pierce: Yes. I do feel many people don't want to think anymore in the organized and disciplined way you must in the natural sciences. Today, for many people, is a day for "feeling your own vibes" or "being yourself." It's not a day for hard effort for people who work outside of technology.

Technology, itself, may be partly to blame for this. Less than 15 percent of the population produce all the goods of society. All the rest do rather abstract jobs, and are far away from the things technology deals with effectively.

Nahin: Did the use of a pen-name, "J. J. Coupling," for your science fiction have

them for practical faster-than-light or time travel. There are certain paradoxical things that can happen on a very small scale. Science fiction writers want faster-than-light travel because they find it convenient to use other solar systems and civilizations in telling moral or adventurous tales. When Samuel Johnson wrote *Rasselas*, he could set it in Abyssinia be-

somebody once pointed out that maybe the reason we don't hear from anybody else is because everybody's listening and nobody's transmitting!

As to faster-than-light travel, that implies time travel, too, if you believe in relativity, and time travel has paradoxes. At the moment I don't believe in faster-than-light travel because relativity seems so simple and true. It follows from very direct and basic arguments and experiments. But I won't rule faster-than-light out, and I would hate to see it disappear from science fiction. All of space opera would be gone!

As to the isolation of Man, that is not inevitable. Way back, Robert Heinlein, who is a great hero of mine, wrote a story called "Universe." It was about a science fiction Noah's Ark. It is perfectly conceivable to have huge space ships that are self-sufficient worlds and that travel for generations. But not now. Not for many, many years. The time for the telegraph wasn't ancient Greece even though much of the beginning work for it was done then. In the same way, the time is not right for travel to the stars. It will come.

Nahin: You once wrote, "Computers look silly only when someone tries to make them walk on their hind legs and beg to be recognized. There should be a Society for the Prevention of Cruelty to Computers to deal with this abuse." In general, you seem to be quite negative about work in artificial intelligence, once having equated the development of computer algorithms for handling natural languages with the discovery of the Philosopher's Stone. Isn't that a funny position for a science fiction writer who thinks machines will explore space?

Pierce: Yes, but then I'm not a full-time science fiction writer. I've often been asked when computers will be better than Man. I always respond that from the very first moment computers have been better than Man at a lot of things. It's only when you ask them to do ridiculous things that they look bad.

You can liken a computer to an airplane. A bird is just wonderful. So is a 747. But a 747 doesn't land on a tree. And if you insist that flying machines flap their wings and land on trees, you'll get very poor flying machines.

Nahin: And dangerous ones, too!

Pierce: Yes. Just like people, computers should have jobs they're good at.

I'm an engineer. I believe it's more important to get the job done than to be ele-

"I picked up the pen name J. J. Coupling from the letterhead of the Institute for Useless Research"

anything to do with a concern about how that sort of writing might affect your technical image?

Pierce: No. When I started writing articles for *Astounding*, rather than stories, I used a pen-name because there was a release procedure for technical material written at Bell Laboratories. What I was writing had nothing to do with Bell Laboratories work, or very little, and I saw no reason to go through this tedious procedure. So I chose a pen-name.

The name "J. J. Coupling" comes from atomic physics. I didn't know what it meant when I chose it, and I'm a little uncertain now. Bill Shockley and Jim Fisk, who later became president of Bell Laboratories, had, while at MIT, founded the Institute for Useless Research. They had a letterhead printed. The president of the Institute was Isaac Neutron and the secretary was J. J. Coupling. I just picked the name up from the letterhead of the Institute for Useless Research.

Nahin: Science fiction uses some seemingly impossible technical devices to help put stories in a "sense of wonder" setting. Some of these, like faster-than-light trips across galaxies, have recently been discussed as being accomplished with the aid of black holes. And professional scientists who are also SF writers, like Robert Forward of Hughes and Gregory Benford at the University of California, have written about time travel in a near serious manner. Do you think faster-than-light space drives and time travel can ever really happen?

Pierce: My authority on black holes is John Wheeler, and he doesn't believe in

cause no one knew anything about Abyssinia. When Voltaire wrote *Candide*, he had all sorts of strange goings-on in the Americas.

But now all of our planet has been explored. There's no place on Earth about which to write romantic fantasy under the guise of possible fact. So the science fiction writers have been driven out of the solar system, almost. Some, like John Varley, still use the planets of our system, but most others have fled to the far corners of the universe. This is a sort of crisis.

Many science fiction writers are caught in the past. They think the exploration of space is going to be like the discovery of the New World by Columbus. They think Man himself will do it. I think it will be automatic machines that will do it, like Voyager. As far as I can see, the future just passed up these science fiction writers, and still does. Man is a terrible encumbrance in space, but it is a natural environment for a machine. A lot of science fiction seems not to have recognized this.

Nahin: To pursue the faster-than-light question, if we can't achieve it then Man will be isolated in his local region of space, and that bothers a lot of people. It has become almost a theological issue — if there really is a benevolent God, then such a cruel fate just couldn't be.

Pierce: Let me make a preliminary comment. Some of the people who don't believe in faster-than-light travel are very interested in SETI (search for extraterrestrial intelligence). My old friend Bernard Oliver, at Hewlett-Packard [vice president for research], is one. That's all right, but

gant. It's good to be elegant, certainly, but the bottom line is that it's gotta work!

As far as understanding how the human brain works, it's the biologists and psychologists who'll do that, not the artificial intelligence people. Here's a quote for *E&S*: "Artificial intelligence is real stupidity." I'll admit it's only a half-truth, but still, it's at least *half* true.

Nahin: In your 1968 book, *The Beginnings of Satellite Communications*, you wrote, "I wonder why I did not think of satellite communications. I believe that I just did not take space seriously, as Arthur C. Clarke had in proposing communications satellites in 1945. I read science fiction, and I wrote science fiction. I liked to talk about space travel — but I did not really see that space was near enough to be of serious concern." And yet, Clarke himself wrote the preface to your book and honored your contributions, and at least one recent book on communication electronics *does* credit you with proposing satellite communications in 1955. Is there some mix-up here, or are you being modest, or . . . ?

Pierce: No, science fiction and space were one side of my thought, and before Sputnik and Explorer went up, I used to go around giving talks about space and space travel. I used pictures taken from V-2s which had been refurbished in this country. Then, in 1954, the Princeton section of the IEEE — it was the IRE [Institute of Radio Engineers] then, of course — asked me to give a talk on a space topic.

That woke me up. I thought that this man-in-space stuff, which is as old as Kepler or even older — remember Cyrano de Bergerac? — wasn't quite the right thing. I wondered what I could say that would be more serious. Since I was interested in communications, I thought of communication satellites. I didn't think of them as *my* idea. I hadn't yet read Arthur Clarke's article. Satellites were just in the air (figuratively speaking!) and I thought *everyone* had thought of communication satellites.

My job wasn't to invent them, but to analyze their possibilities. So I gave the talk, and later I was asked to write it up for publication. This got me thinking, but there wasn't anything to do about communication satellites then because there was no way to put anything up. When Sputnik went up and Explorer went up, I thought this was the time to do something. That led to Echo, and Echo did several

things. It made the front page of the *New York Times*. It hit the people at AT&T, and that led to Telstar.

Nahin: It is no secret that NASA has had a public relations problem, and hasn't really succeeded in convincing the American people that its charter is essential to the country. Recently the agency's head, Robert Frosch, resigned over a failure to get the budget it needs. As a person intimately involved in the operation of a NASA lab, what do you think the future holds for our space exploration program?

Pierce: That depends on the health of the country, materially and mentally. As far as I'm concerned, one of the few good things that happened during the Carter administration was Voyager. It caught the attention of people, and it was a cheerful thing. It buoyed people up. America did something that everyone admires. Countries have to do some things beyond what is of day-to-day use. But of course the unmanned space program *has* done things of day-to-day use too. It does them for the

The rockets that have actually launched all the commercial satellites are military derivatives of the Atlas, and the Thor, which became the Delta, and the Titan. NASA has persisted in believing that the way to appeal to the public is Man in Space. I think this has been an unhappy decision. It's a good thing to work toward, but you do that by improving technology. You don't do it by an all-out drive to replace all the unmanned launch vehicles, which have been so useful, with a manned vehicle where success and economy are so hard to attain.

Nahin: As a final question, what technical developments do you see in our future?

Pierce: The area that is really taking off now is biological science, with wonderful new advances coming almost daily in things like genetic engineering of bacteria. In electronics I think the very large scale integration of circuits is most exciting, and I could go on almost endlessly listing what that implies. But let me be somewhat more philosophical instead.

"I look for a digital future, but the thing that concerns me most about it is not privacy but accountability"

military in surveillance of the Soviet Union, it does them in navigation through NAVSAT and through the Global Positioning System, it takes pictures that are useful in exploring for resources and for monitoring the weather.

If the country gets out of its doldrums, it *can* afford other less immediately useful things. Certainly, the poor will always be with us, but one doesn't live by bread alone. I regard this as a time in which the country wastes billions of dollars because we have so many Mammon worshippers who think they can cure any ill by spending a lot of money. That just isn't so. In their ill-conceived way Mammon worshippers overlook opportunities that could push Man's capabilities ahead, as I believe the unmanned space program does. NASA has a problem because Apollo went over so big. Well, Apollo was a dead-end in some ways. We'll not build such big and expensive rockets as Saturn V for a very long time to come.

I look for a *digital* future, one in which the world will be much more under the individual's control. People, today, who comment on the future for a living, keep talking about *privacy*, and things like electronic snooping in personal data files. But the thing that concerns me most about the digital age is *accountability*. As T. S. Eliot said in "The Rock,"

Where is the Life we lost in living?

Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

And I add, where is the information we have lost in data? The government collects huge amounts of indigestible figures that don't mean anything to anyone, and spends billions doing so. Future developments in computers could turn this around and let the individual have meaningful access to these large data resources. *Before* they get manipulated in unknown ways by unknown people with unknown motivations. □