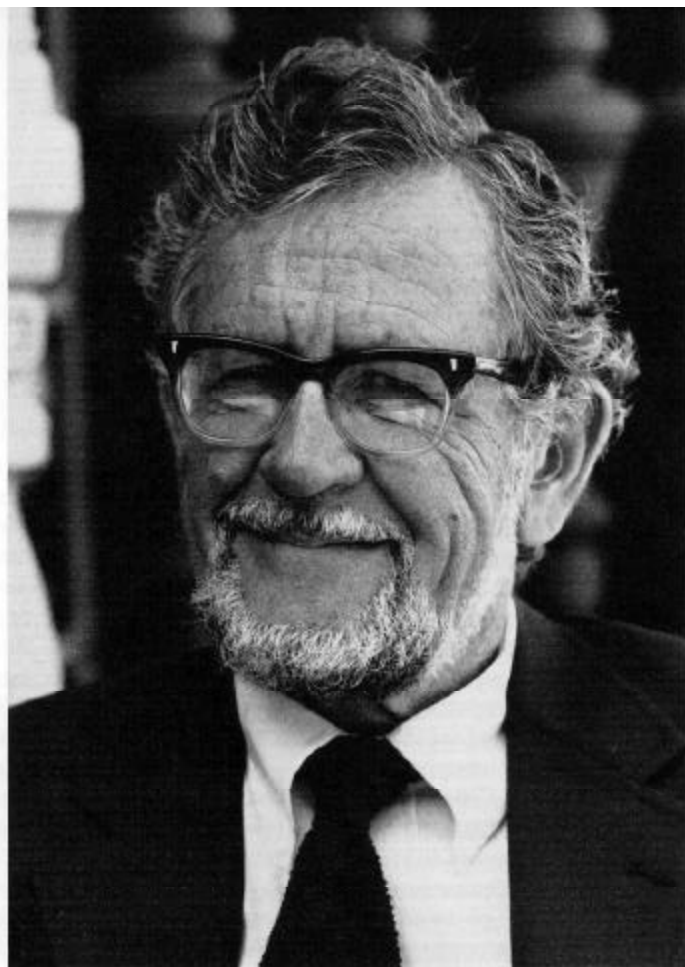


JDR



Anyone familiar with the initials above also knows something's wrong with them. Over the years "JDR" has been signed to countless memos, reports, and other papers, but seldom in any color but bright red. JDR — John D. Roberts — has never left doubt in anyone's mind about what he thinks or the fact that it is he who thinks it. So his signature and comments tend to be as visible on a paper as his craggy, 6'4" frame is on the campus — and was even before he added the administrative jobs of vice president, provost, and dean of the faculty to his academic position as Institute professor of chemistry.

That many titles and the responsibilities implicit in them should suggest a busy man and one who knows his way around collegiate traffic patterns. Certainly they describe Roberts, who has been steering his way with skill, distinction, and dispatch through the jobs of teacher, researcher, administrator, consultant, and writer almost from the day he graduated from UCLA. It must be a coincidence that the four-level freeway exchange in downtown Los Angeles sits on the site where he was born in 1918, but probably the only more appropriate way of honoring his nativity would have been to construct LAX there.

Of course, juggling jobs and time didn't begin for Roberts on commencement day 1941; he started at least as early as high school by being lab assistant and reading

papers for his physics teacher. For two years at UCLA he carried a full academic load and worked in a bakery six nights a week from 7 until midnight. Fortunately, by the end of his sophomore year, he was doing well enough in chemistry to be offered a part-time research job that paid real money for something he loved doing.

It was no surprise around the Roberts house that Jack was making a mark in science; he'd been pointing in that direction for a career ever since he got his first chemistry set at about the age of 12. Members of the family were tolerant of the occasional noisy and/or smelly episodes in his garage laboratory, but neighbors whose radios couldn't rise above the interference from a highly activated Tesla coil were somewhat more critical.

He was also strongly influenced toward science by the popular books about scientists and their work published in the late 1920s and early 1930s, and he read most of them. In fact, learning about Eddington, Jeans, and Einstein took him on a brief detour in interest from chemistry to astronomy where, he says, the required level of math soon sent him back to earth.

Caltech was an early magnet too, and as a teenager he was a frequent and fascinated visitor to campus on open-house days. He considered coming to the Institute as an undergraduate, and his mother corresponded with Robert

Millikan about the possibilities. But the stringencies of the Depression were very real in the Roberts family. His father's heating business went bankrupt, and there were two other children to get through school. When he balanced monastic Caltech's tuition of \$300 a year against coeducational UCLA's less than \$60, the choice became simple.

The first Roberts research paper was published in 1940 (with William R. Crowell and Caltech's Don Yost), and he received his bachelor's degree in 1941. While he always got A's in science courses, he didn't do so well in some others. English composition was his particular *bête noire* until one of his chemistry professors took the time to show him how to use the English language in scientific writing, in the process instilling in him a respect for its importance. He also taught Jack how to do the meticulous drawings that have become his trademark. Considering the more than 400 research papers and 7 books that now have the Roberts name on them, that pedagogical dedication was a sizable contribution to chemistry.

In 1942 Jack married Edith Johnson, whom he had met in high school. One of the material assets Edith brought to the marriage was a spinet piano, and its presence in their apartment gave Jack the opportunity to experiment with do-it-yourself music lessons. He elected to do this by alternately listening to a recording of the first and second movements of Beethoven's "Moonlight Sonata" as played by Paderewski and then trying to play them himself. The ultimate result was a fair amount of musical accomplishment — at the cost, says Edith, of some cooling of their relations with the downstairs neighbors.

Incidentally, there was no tie-in between his choice of a Polish pianist to emulate and his own maternal Polish connection — a tie that was supposed to show up in his middle name. His mother wanted that name to be Dombrowski, which was her family name and that of a famous ancestor, General Jan Henryk Dombrowski, liberator of Poland in the Napoleonic era. To her sorrow, whoever made out his birth certificate put down only the *D*, so legally JDR has just a middle initial.

Throughout his years at UCLA Roberts worked on reaction mechanisms in organic chemistry, mostly with William G. Young and Saul Winstein, two UCLA faculty members who obtained Caltech PhDs with the much beloved Howard Lucas. He also did war-related research, having been kept out of active military service by a hearing loss — the result of scarlet fever incurred at age 10. He received his PhD in 1944, and in 1945 went to Harvard as a National Research Council Fellow. A year later he became an instructor in chemistry at MIT, and by 1950 he was an associate professor there.

Roberts remembers 1950 for at least two other reasons. He began his association with E. I. du Pont de Nemours as a consultant — an association that still continues — and he first heard about the potential of NMR over a lunch table at MIT. In the eyes of the world, chemical applications of

Nuclear Magnetic Resonance is an area that eventually became almost synonymous with John D. Roberts. Ironically, with his weak background in physics, NMR was just part of the alphabet to him in 1950. It was not until four years later, after he had come to Caltech, that in the course of a consulting visit to du Pont he really became aware of NMR's possibilities for chemical research.

"I came back from that trip," he says, "and went to work persuading the division chairman, Linus Pauling, to buy the equipment, which wasn't easy because Linus had trouble believing that organic chemists could fruitfully use such sophisticated instrumentation. Then when the equipment came, I knew a lot of what it could do, but I didn't really know how it worked."

He soon learned. By 1970 his colleague George Hammond — also a distinguished chemist — could write: "Roberts's work in the field of molecular orbital calculations and Nuclear Magnetic Resonance is of paramount importance in modern organic chemistry. Today, nearly every student of organic chemistry casually feeds secular determinants to high-speed computers and admires the parameters generated by the electronic brain. Roberts was doing the job when one had to diagonalize matrices by direct use of group theory and drudgery. If Roberts had not entered the field of NMR at an early stage, I believe that the field would have developed differently and far less effectively." (In *John D. Roberts: On Thirty Years of Teaching and Research*, a 1400-page volume published by W. A. Benjamin, Inc., in honor of its best-selling author on the occasion of the tenth anniversary of the founding of the Benjamin firm. Further remarks from this book by Benjamin himself and by a Roberts graduate student, George Whitesides, will be found on pages 12 and 13.)

NMR is a precise and comparatively rapid method of studying a wide variety of molecular properties. It is effective only when the molecules contain certain kinds of atomic nuclei, the most important being hydrogen, deuterium, carbon-13, nitrogen-14 and 15, oxygen-17, fluorine-19, and phosphorus-31.

A vial containing a small sample of the substance to be analyzed is placed in a strong magnetic field (nowadays up to as high as 120,000 gauss; the earth's magnetic field, by comparison, is less than one gauss). The strong magnetic field induces the nuclei of the molecule's atoms to line up as compass needles do in the earth's magnetic field. When aligned, these nuclei will "receive" certain radio frequencies that are beamed at them. An NMR spectrum is obtained in effect by tuning across the dial of a radio transmitter and recording which frequencies are absorbed by the sample. This recording appears as a series of peaks on a graph. The locations of the peaks permit identification of the atoms, and the heights of the peaks are proportional to the number of atoms present. By carefully interpreting the data, the investigators can determine the structure of the material in the sample, whether impurities are present, and in what amount.

Some of the "practical" results of NMR research at Caltech have been contributions to understanding the nature of the important industrial polymer polypropylene, the macrolide antibiotics, and the structures of steroids, alkaloids, and enzymes.

The techniques and the instruments have gotten more sophisticated and effective over the years, of course. A fairly new NMR machine in the Roberts lab is now being used to observe the rare isotope nitrogen-15 in enzymes (memorialized as N15 NMR on the license plate for the Roberts Honda). The machine has a cryogenic magnet (that has to be maintained with liquid helium at temperatures within four degrees of absolute zero) with a high magnetic field strength (45,000 gauss) and extraordinary uniformity of field (better than one part in 20 million over a volume of about one cubic inch).

All this was in the future, however. After spending half of the academic year 1951-52 as a Guggenheim Fellow at Caltech, Roberts returned in 1953 as a 35-year-old member of the faculty to fill the hole left by the retirement of Howard Lucas — and brought with him, says Harry Gray, current chairman of the division of chemistry and chemical engineering, "an international reputation as an organic chemist." He also brought with him an MIT woman graduate student, Dorothy Semenow, and a dilemma for all-male Caltech. The story persists that Roberts refused to accept an Institute appointment unless and until Semenow was granted admission, but Roberts labels that a myth. He does say, "I was very pleased to be able to find that the Caltech faculty could make such a drastic change in established policy in just a few months."

In the eyes of many, the ability to persuade demonstrated by Roberts in this instance — and many another thereafter — amounts to genius. Speculation about his methods is laced with both envy and admiration. David Morrisroe, Caltech's vice president for business and finance, thinks he does it "by expecting considerably more from people than people think they can do. This has a very positive effect. He shores it up with a certain tenacity in follow-up that pretty much assures achievement, and he's good at picking a point where a reasonable compromise can be made. Maybe it's the mark of a good experimentalist—that he doesn't persist when the facts overwhelm his ideas."

A case in point for the efficacy of Jack's expectations is the way Robert Ireland, professor of organic chemistry, found himself chairman of the Athenaeum's House Committee in 1976. As Bob remembers the sequence of events, Jack agreed to become chairman of the Board of Governors for the ailing faculty club on condition that Bob would take on the House Committee. "I kept saying no," says Bob, "and Jack kept saying OK and going away — and then he'd bring me stuff about the Athenaeum and its problems. Maybe the basic problem was that I just couldn't say no to Jack. Eventually there I was, running a reorganization-of-the-Athenaeum project."

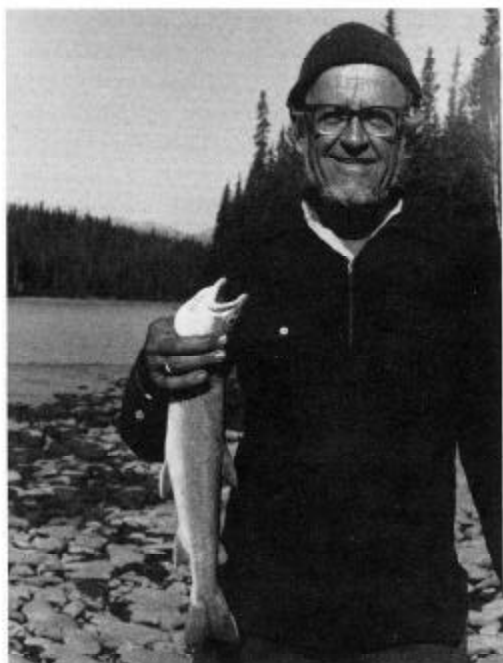
Anyone who has made use of the revitalized Caltech faculty club in the last year or so will testify to the spectacular success of that project and partnership. As a matter of fact, Ireland worries that the Athenaeum is now so overused and overscheduled that the staff and physical facilities may not be able to continue to cope.

Roberts has an intellectual understanding of that problem, but he also wishes more of the faculty would eat lunch at the Athenaeum with their colleagues. "I know some people aren't geared to that kind of socializing," he says, "and I know it isn't easy to sit down at a table with seven strangers. But it's a great way to get to know people. What helped me when I first came here was that Carl Niemann, who was a well-known member of the chemistry faculty, would take me there every day and introduce me to whoever was at the table where we sat."

The 27 years between 1953 and 1980 have seen Roberts reap an astonishing number of honors and awards — in recognition, of course, of an equally astonishing amount of hard work and scientific achievement. "He's without doubt one of the greatest organic chemists in the world," says Gray, "and he's won every award you can think of except the Nobel Prize, which he deserves. He's made very important contributions to chemical education, and his book (*Basic Principles of Organic Chemistry*), written with Marjorie Caserio, is the landmark text in organic chemistry in the last half of this century."

When the first edition of that book was published by W. A. Benjamin, Inc., in 1964, Roberts had been a director-editor of the firm since its founding in 1960. Reminiscing about Roberts's perfectionist attitude and the publication experience, Benjamin wrote in 1970 that "producing a text of that size and scope was the most monumental task a small publisher could possibly undertake. Then add Roberts in the role of senior author, and the adjective 'monumental' is reduced to a feckless pun. I doubt that anyone has any idea of the enormous amount of work that Jack and Marjorie put into this textbook during 1962 and 1963. Much of the manuscript had already been through early drafts, and yet they wrote and rewrote again and again. And we reviewed and rereviewed. Then some 2000 pages of manuscript, roughly the size of three normal books, began to engulf our Broadway headquarters. . . . Once we placed the copy-edited manuscript in the hands of the typesetter, everything began to go wrong. Roberts raged and pleaded, both at long distance, and eventually things began to work. . . . Through one crisis after another Roberts reigned over the entire production process and in the end knew as much about publishing techniques as anyone on our staff."

The teaching of chemistry courses and the care and feeding of graduate students have also occupied a fair amount of his time at Caltech — though his concern for them has not always been evident to the student recipients. This troubles Roberts, but he feels that if he avoids trying to "mother-hen" them, the students are more likely to



JDR's life has not been all slaving over academic obligations or even over a hot (or cold) NMR machine. He's also had some fun. At the left, John Izaak Walton Roberts proves he's a complet angler, and above with wife, Edith, and son Donald he mans the tiller of the family sailboat.

realize — and rise to — their true potential. The results of this attitude have been mixed; a few students have been a bit unhappy, but 46 have earned their PhDs or are at work on them. JDR himself has taken some good-natured razzing about the process, notably from George Whitesides (PhD '64, the Haslam and Dewey Professor of Chemistry at MIT, and a recent recipient of a Caltech Distinguished Alumni Award), who describes the Roberts method of selecting graduate students as “shaking the box to see what falls out.”

The one avenue of communication that graduate students had with him, Whitesides goes on, “was strictly one-way: we wrote monthly progress reports, which, in his absence, we left in his office. We never saw the reports again, and their contents elicited no comment. Our emotional condition as we abandoned these reports on his desk must have resembled closely that in which earlier and (presumably) more primitive cultures tied offerings of chickens in the forest to be eaten by trolls.

“... If Roberts was hard to find in the normal course of events, he compensated by going to considerable effort to read thesis drafts as rapidly as the students could produce them. . . . As drafts were submitted and returned, it rapidly became obvious that, contrary to popular opinion, he *had* followed the progress of the research. In fact, he knew not only the details that had been included in the progress reports, but also details which he had no earthly reason to know. To this day, I have no idea how he came by some of the information he pencilled into the margins of my thesis. Certainly I never told him; perhaps it was divine revelation, perhaps *a priori* reasoning. Regardless, although disillusioning at the time, this final exposure to

the realities of the situation provided a therapeutic conclusion to the graduate educational process.”

It's only fair to point out that there are other equally strong and much more serious testimonials to the Roberts rules of order in regard to critiques. He may — and does — vigorously attack the ideas of a colleague with whom he disagrees; he never opens fire on people.

Now Jack's life has not been all slaving over academic obligations or even over a hot (or cold) NMR machine. There have been trips to most corners of the world (to give lectures, receive awards, attend conferences, vacation, or just to contemplate the scenery while planning and/or writing a book), fishing, sailing (he has his own boat), skiing (two broken legs), whitewater river trips with his sons (who are professional-level boatmen), and tennis (he experiments with new kinds of rackets as they appear on the market and hovers near the top of his division of a most informal Institute tennis ladder). He also continues to be interested in classical music (and still plays the piano now and then), and he does a lot of computer programming and color photography.

Most importantly, there are the four Roberts children, who were born between 1951 and 1955 — Anne, Donald, John Paul, and Allen. “With all the time and energy that my doing science involved,” says Jack, “Edith had to be the major influence with the children, and she's just been fabulous.” However it has been done or by whom, the Roberts child-rearing system has produced remarkable results. (“They're all intellectual giants,” says Ireland.) Two of the boys have just received their MD degrees, and the third is an electronics engineer. Daughter Anne has just begun her third year in medical school, a bit behind

her younger brothers because she got a master's degree in history before deciding to go into medicine.

When Roberts was asked by Caltech President Marvin Goldberger to consider taking over the posts of vice president and provost upon Robert Christy's retirement in January 1980, he already had plenty of experience with administration. From 1963 to 1968 he was chairman of the division of chemistry and chemical engineering and was its acting chairman from 1972 to 1973. He had served on a number of committees at Caltech and for the National Academy of Sciences and the National Science Foundation. So he should have been able to make an educated estimate of what was likely to be involved. He knew, for example, that he would be winding down his research. "There are a lot more things it would be fun to do," he says, "and some that we can still probably do better than anyone else. But the demonstration part of NMR is about over, and this is an appropriate place to start to close things down."

Roberts also had experience being a member of the faculty under the two previous vice presidential provosts — Christy and Robert Bacher — and under their predecessor, Earnest Watson, who did a somewhat similar job under the title of dean of the faculty. Jack respects and admires each of them, and envies what he perceives as their poise in difficult situations.

In speaking at the first faculty meeting after his appointment was announced last December, Roberts defined his concept of the different requirements for wearing each of his new hats. "As vice president," he said in part, "I expect to assist the president by helping to decide controversial issues — through gathering data, opposing points of view, and alternative courses of action. If it should happen that an important decision has to be made quickly, when Murph is not available for consultation, I will be empowered to act for him. The efficiency of modern communication makes this unlikely to be an important function.

"If you ask people what a provost does, you will get different answers. Webster is not much help; among the definitions he offers is 'keeper of a prison.' More to the point but still vague is 'high-ranking administrative official of an American university.' The Caltech provost has been traditionally the chief academic officer, and within the guidelines set by the president I plan to be just that.

"When I came to Caltech 25 years ago, Earnest Watson was dean of the faculty, and the faculty seemed to like the idea of someone fulfilling such a function. I asked Murph to recreate the position because I want the faculty to know that someone represents their concerns in the administration. Furthermore, I know that the greatness of Caltech resides in its faculty, not in its administration, and I want to contribute to the strength of the faculty in the years ahead. It is as dean of the faculty that I expect to work with the division chairmen in matters of appointments, promotions, and salaries.

"Bestowing all of these titles on one person may seem to raise issues of conflict of interest, but it does avoid increasing the administrative bureaucracy and thereby saves money and office space. Furthermore, one telephone extension will suffice for the several functions."

Ten months later, Roberts finds that some of the lightheartedness with which he spoke on that occasion has faded. No amount of previous experience could have prepared him or anyone else for the diversity of issues involved and for the scarcity of money for projects and salaries. Worrying about the rate of inflation, the realities of the economic recession, and the increase in the cost of utilities (double what they were a year ago) is keeping Vice President, Provost, and Dean of the Faculty Roberts awake nights. "There are so many good people here," he says, "with so many good ideas about things to do, it is a terrible responsibility to decide among them. I listen to the proposals and wonder if I can ever get the whole picture into perspective; and I feel pretty defensive about having to be 'encouragingly' negative about so many things. It's tough to have to risk losing any of our good people, and they are good — creative, imaginative, and forward-looking. It's also tough to think about not being able to bring in the best new ones because of space and financial problems."

He is also concerned, as many of the faculty and administration have been before him, about how the Institute can continue to change — as it must if it is to maintain its high academic standing — without substantial growth — a route to change that Caltech has traditionally resisted, though it is used by many universities. He has to be even more concerned than his predecessors about wage and salary guidelines, the high cost of housing for grad students, postdocs, and young faculty, and the recruitment of qualified scientists and engineers from inadequately represented groups, ethnic and female.

One approach he is using to get a better understanding of faculty points of view is to keep an open office door; another is to take faculty members from different divisions to lunch each Friday. He began at the level of the first-year assistant professors and is working up the academic ladder, hoping eventually to have broken the Athenaeum's noontime bread with every professor, including those he's known for years. He has found it particularly rewarding to trade ideas and information with the faculty in this context.

Such exchanges can't help but be beneficial in many ways. Roberts is doing a lot of careful planning these days and making a vigorous effort to enlarge the Institute's resources and capabilities, but he's having to make some thorny choices. JDR may sign his name in red ink, but he doesn't like that color on the bottom line of Caltech's balance sheet. More importantly, he believes that Caltech's strength derives from its faculty being able to work on the things they feel are most significant. His goal is to help them do just that. □