Richard MacNeal, ca 1963

RICHARD H. MACNEAL
(b. 1923)

INTERVIEWED BY
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Subject area

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Abstract

An interview on January 23, 2002, with Richard H. MacNeal, former chairman and CEO of the computer software firm MacNeal-Schwendler Corporation (MSC). Dr. MacNeal received his BA from Harvard (1943) and his MS (1947) and PhD (1949) from Caltech in electrical engineering, studying methods of stress and vibration analysis using the analog computer in Gilbert McCann's Analysis Laboratory. After receiving his PhD, he became an instructor and then an assistant professor at Caltech in what was then known as the Division of Civil, Electrical, and Mechanical Engineering and Aeronautics (now the Division of Engineering and Applied Science). In the early fifties, he helped found Computer Engineering Associates (CEA), a Caltech spinoff; in 1955, he left Caltech to work there. After six months, he went to work for a year at Lockheed. He then returned to CEA, where he was a director until 1963, when he founded MSC, participating in the NASA-sponsored project on computerized structural analysis that became known as NASTRAN (NAsa STRuctural ANalysis program).

In this brief interview, Dr. MacNeal recalls the early days of analog computing at Caltech and the consulting work that the Analysis Laboratory, and later CEA, did for aircraft companies. Concludes with comments on Caltech's initial failure to go into digital computing, the death of analog computing, and the important contributions made by analog computers.

Administrative information

Access

The interview is unrestricted.

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CALIFORNIA INSTITUTE OF TECHNOLOGY ARCHIVES

ORAL HISTORY PROJECT

INTERVIEW WITH RICHARD H. MACNEAL

BY SHIRLEY K. COHEN

PASADENA, CALIFORNIA

http://resolver.caltech.edu/CaltechOH:OH_MacNeal_R

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Interview with Richard H. MacNeal **by Shirley K. Cohen**
Pasadena, California

January 23, 2002

Begin Tape 1, Side 1

COHEN: Good morning, Dr. MacNeal. It's very good of you to talk to us. Perhaps we could start out by your telling me a little bit about your family and your early education.

MACNEAL: OK. I grew up in Philadelphia. I went to Harvard College in 1940. In 1943, I graduated with a Bachelor of Arts degree in engineering.

COHEN: That's unusual, isn't it?

MACNEAL: It isn't unusual. In fact, whether you got a BA or a BS depended on how many years of Latin you had in high school. [Laughter] Since this was during the war, I immediately went into the service. I was in California when I was discharged in April of 1946. In May of '46, I married Carolyn, and in September of '46 I started at Caltech as a graduate student in the electrical engineering department.

COHEN: What attracted you to Caltech?

MACNEAL: Well, it wasn't the football team. [Laughter] We were living in Pasadena. As a matter of fact, Carolyn was working at the offices of the Mount Wilson Observatory.

COHEN: Oh, really. She would have a story to tell, too. [Laughter] Was your family from this area?

MACNEAL: No. They were from Philadelphia. But we liked it so much that we decided to stay

out here rather than go back east.

COHEN: You were sent here by the service? Is that how you got here?

MACNEAL: Yes.

COHEN: That's how many people found California.

MACNEAL: That's right. In September of '46, I entered Caltech, and I got my PhD degree in electrical engineering in '49. So that's my early history.

COHEN: Was there a reason why you went into that? Had you been doing engineering kinds of things already in the army or something?

MACNEAL: A little bit. Yes. As a matter of fact, there was a project out in the desert that I was involved with that used a little bit of science that I had learned at Harvard.

COHEN: What project was that?

MACNEAL: This was a project to analyze the trajectories of bombs that were dropped from high altitudes. In fact, at that time the Aberdeen Proving Ground was run by astronomers, including Edwin Hubble, who was the director of the analysis laboratory at Aberdeen. When I wanted to get into Caltech, I got a letter from him, which I never read but which did the job. [Laughter]

COHEN: That's what counts.

MACNEAL: Because, naturally, going to Harvard, I hadn't spent all of my time in engineering, and at that time Caltech still required a lot of subjects that I hadn't taken. They were looking at me, and they said, "Well, you haven't had this and you haven't had that." But when they read Hubble's letter, they said, "Show up in September, and, oh, by the way, during the summer we want you to read all about fluid flow and all these other things that you don't seem to have had to study." Anyway, it was fine. So there I was. I guess the next thing is, How did I get involved

with computing?

COHEN: How did you get to Dr. [Gilbert D.] McCann [professor of applied science, d. 2003]?

MACNEAL: Well, taking electrical engineering courses. McCann was hired by Caltech at the same time that I arrived, and he taught classes. He told us that he was setting up this laboratory. I think it was sometime in '47, probably in the fall of '47, that I became interested in doing research work, after having finished my first year. My first year as a graduate student at Caltech was really rather rough, after having been away in the service for three years.

COHEN: I can imagine.

MACNEAL: It was an entirely different approach from that at Harvard, which was more cultural. The approach at Caltech was more precise, more engineering-oriented. They wanted real answers to problems rather than talking about them.

COHEN: Did you enjoy that?

MACNEAL: Not at the beginning, but I learned to appreciate it a great deal. As a matter of fact, this emphasis on getting numerical results, or on getting formulas that could be converted to numerical results, was part of my interest in getting into the Analysis Laboratory. I could see that the way engineering mechanics was being done was very old-fashioned and couldn't solve more than the most trivial problem using analytical methods. You really needed to have computers in order to do the job—and new methods. So I got involved on the side in studying the methods, all kinds of numerical methods. I was quite interested in the work that was going on there. In fact, of course, you've noticed that I've written a thesis about that subject.[1]

COHEN: Right. Where did you live when you were here?

[1] Richard H. MacNeal (1949) *The solution of partial differential equations by means of electrical networks.* Dissertation (Ph.D.), California Institute of Technology.

MACNEAL: We lived in Pasadena.

COHEN: Did Hubble actually really influence you a lot in coming here?

MACNEAL: No. He was about eighteen levels above me in the organization. The only time I ever saw him personally was when I went to ask him for a letter. Apparently somehow he must have heard of my work, although I have no idea what he said.

COHEN: Well, if he were a good head of things, he would know what everybody was doing, I suppose.

MACNEAL: Yes. Well, I was enlisted; I was not an officer.

COHEN: I see. So you were just assigned to do that.

MACNEAL: In those days, you could do quite a bit. Aberdeen was more like a research organization than it was like a military organization. So I got to do a little bit of research, and apparently he heard about that. [Laughter]

COHEN: Who were some of the people you enjoyed taking courses from when you first came to Caltech?

MACNEAL: Of course, everybody mentions Bill [William H.] Pickering [professor of electrical engineering; director of Jet Propulsion Laboratory 1954-1976; d. 2004]—not a good teacher, but a marvelous personality. He could really interest people in projects in all kinds of things. He had a wonderful personality. I would say Royal Sorensen [professor of electrical engineering, d. 2004], with his vast experience, and telling us how, when he was a young man, he would go to a bar and buy a beer for five cents and get a free lunch—that's the way he ate lunch when he was at GE [General Electric] in the very beginning. I guess those two are the ones who come to mind the most.

COHEN: They would have influenced you if you still remember them this many years later.

MACNEAL: Sure.

COHEN: So you proceeded to take the courses that were required. When did you get into actual research at the lab?

MACNEAL: After the first year. The first year of graduate work at Caltech, in those days at least, was satisfying course requirements. After that, you were supposed to begin getting into research activity, which I did. I guess it was sometime in late '47 that I got involved.

COHEN: Right. So Dr. McCann already would have been well established in setting up his analog lab by then.

MACNEAL: Yes. The construction of it was completed by the time I showed up on the scene.

COHEN: So you came into a finished facility, in some sense.

MACNEAL: Pretty much.

COHEN: What was the lab used for at that time?

MACNEAL: It was just starting to be used. At Westinghouse, McCann—Mac—along with Harry [E.] Criner, had worked out how to model beams with electric analog computers, using transformers as a primary agent. For vibrations, you would use inductors for stiffness and capacitors for mass. One of the first things I did was to take a look at what he had done and rearrange it somewhat. There are two methods of circuit analysis in electrical engineering: There is the loop method, where the unknowns are circulating currents, and the node method, where the unknowns are voltages. Criner and McCann had worked on this—basically this was the basis of this computer that they had developed. They said, "We will be able to solve beam problems with this new method." One of my first jobs was to convert the thinking from using currents as the unknowns to using voltages as the unknowns. It turned out the circuit was identical—well, this was my first little piece of work.

In those days, airplanes were analyzed as beams. There was one beam for the fuselage,

one beam for the left wing, one beam for the right wing, and little beams for the vertical stabilizer and the horizontal stabilizer. The whole thing was what we used to call a stick model. You'd get a stick model of a beam. Chuck [Charles H.] Wilts [professor of electrical engineering and applied physics, d. 1991], in particular, got interested in representing the unsteady aerodynamics with the analog computer. So, with the unsteady aerodynamics represented by amplifiers—active circuitry—and the structure represented by passive circuits—transformers, inductors, and capacitors—we were able to represent the dynamics of an airplane that's flying along. One of the most serious problems in aircraft structural analysis is the flutter problem, which is the instability issue. We got to the point where we could do that fairly well. Then McCann started to go out to talk to the local aircraft companies—of which there were quite a few; there was Lockheed, Douglas, and North American—about their particular problems.

COHEN: Did they solicit him, or did he just go to them?

MACNEAL: I was a lowly graduate student, I don't know. I rather suspect that Mac was pretty good at soliciting, and that was his job.

COHEN: Was he looking for more money?

MACNEAL: He was looking for money to support the Analysis Laboratory.

COHEN: Right. So he thought this was a good source for it.

MACNEAL: Yes, it was. As a matter of fact, we began to do analysis work for the aircraft companies. My job was basically to extend the theoretical development. For example, a delta-wing aircraft would be coming into use a little bit later, about 1949 and later than that. How were we going to make an analog computer model of a plate? You could represent a long straight wing as a beam, but now they had wings that were short and more triangular in form, and it would be better to represent them as plates. You'll remember that in my PhD thesis—

COHEN: Which I didn't read all of.

MACNEAL: One of the chapters in that is the analysis of plates with analog computers. It was just the beginning of that work. Shortly thereafter, it got to the point where it was practical to use for a real structure with non-rectangular boundaries. About this time, it was beginning to be realized that the size of the analog computer in the Analysis Laboratory was too small. I mean, it was fine; I don't know how many transformers it had—maybe thirty or forty, something like that, enough to analyze a beam. But a plate required a grid-work of circuits of this sort. So the size of the analog computer was increased to the point where it had roughly a hundred transformers, and now we could actually do useful work in analyzing—

COHEN: So you increased the size at that point.

MACNEAL: We increased the size, yes. The research I was interested in was extending the use of the analog computer to two-dimensional structures—to plates and eventually to curved shells.

COHEN: Now, did you have much to do with the rest of the engineering division? Did other people participate?

MACNEAL: Well, I taught classes—Professor [Frederick C.] Lindvall's course, the famous EE226, the highest numbered course at Caltech, I think. [Laughter] It was a course in mathematical methods for solving advanced problems in engineering in general. I was Professor Lindvall's assistant in that course for a year or so, and then he decided that he had other things to do, and I took it over and taught that course. Some of the students I taught still remember it as being one of the high points of their graduate experience. The things that they learned there were valuable to them. So that was my other contribution to Caltech.

COHEN: Right. So then you finished up your thesis.

MACNEAL: In '49.

COHEN: Did you stay on, or did you go somewhere else?

MACNEAL: Well, as everyone else was, I was interested in where I was going to go from there. I

started to apply to companies—like GE, for example. But Professor McCann said, "Why don't you stick around and stay on the faculty? We'll make you an assistant professor if you do." Well, I was very much impressed by that. I didn't realize how low the pay was going to be. [Laughter]

COHEN: That's still unusual, to go straight from graduate student to being an assistant professor.

MACNEAL: As it turned out, I didn't. He didn't deliver on the promise. [Laughter] One year later he did. But the first year, somebody insisted that you couldn't hire this kid as an assistant professor, so I became an instructor or something like that. Then I was an assistant professor and stayed on for—

COHEN: Well, you must have enjoyed the atmosphere of the Institute to do that—I mean, as opposed to industry.

Richard MacNeal, 3rd from the left. Electrical engineering faculty, 1955 *Big T* yearbook.

MACNEAL: Oh, yes, I definitely did. But I eventually decided to leave [1955].

COHEN: Why was that?

MACNEAL: My research was getting sterile. It needed the stimulus of the real engineering world in order to do what I wanted to do. Also, by that time we had formed Computer Engineering Associates.

COHEN: Who is "we"?

MACNEAL: "We" includes McCann, Chuck Wilts, Bart Locanthi, Criner, Bill [William J.] Dixon, and me. We formed this company.

COHEN: Was this before you finished your degree, or after?

MACNEAL: I think it was after. I think it was '51 or '52.

COHEN: Why did you do this?

MACNEAL: The reason we did it was that the Analysis Laboratory was taking in quite a lot of commercial work from the worldwide aircraft companies, and farther afield, it turns out. The reason for doing it was to take this commercial work elsewhere. Somebody thought that it wasn't particularly appropriate for Caltech to be doing commercial work internally. So Computer Engineering Associates was formed in order to do this commercial work and to build these analog computers that other companies might want. I think we built a half dozen of them ourselves. It's interesting. McCann and Criner being older, they did all of the work in forming the company. The amount of money that I contributed was, I guess, $100, or $200, or something like that. But we all received roughly equal shares in the company.

COHEN: I see. It didn't matter what you put into it.

MACNEAL: Yes, and where the money came from, I never knew.

COHEN: That's not surprising. You young people were probably doing the muscle part and the thinking part.

MACNEAL: In 1955, I left Caltech and worked for six months or so, I think, at Computer Engineering Associates. Then I went on to Lockheed in Burbank. I worked a year there, and then I came back to CEA and stayed there for five or six years before I started my own company.

COHEN: Did you continue with the analog computer ideas, or did you develop into other things?

MACNEAL: Well, the digital computer was coming along. I would say that up until about 1960, the digital computer was not much competition for the analog computer. The analog could do things that the digital could not do. As a matter of fact, I visited Paris in 1968 and went to the aircraft company Sud Aviation, where they had the world's largest analog computer. They were doing the wing-fuselage intersection of the Concorde airplane. I went there—this was in '68—trying to sell them NASTRAN [NAsa STRuctural ANalysis program]. They said, "How far along is it?" It wasn't released yet, and they said, "This is interesting, but we are really more interested in seeing the author of this book, which we have used to develop our machine."

COHEN: Your *Electric Circuit Analogies for Elastic Structures*.[2]

MACNEAL: Right. They took me out and showed me this *enormous* room—it was much bigger than the Analysis Laboratory at Caltech—where they had an analog computer that had, I think, 2,000 transformers in it. There were dozens and dozens of young men running around. I asked them how long it took them to do one loading condition. They said it took five days, and I said, "Well, I guess that's all right." [Laughter] But this is the last and largest use of the analog computer, because about that time the digital computers were coming onboard. In about 1970, when NASTRAN was released, it spelled the death of the analog computer. I can remember when we started our little company, the MacNeal-Schwendler Corporation. In the beginning, we were in both the digital side and the analog side. As a matter of fact, the first thing we did was to develop a digital computer program which exactly simulated what was in the analog, which is a novel approach to doing structural analysis, I must say. It has never been repeated. [Laughter]

[2] Richard H. MacNeal, *Electric Circuit Analogies for Elastic Structures* (Hoboken, NJ: Wiley, 1962).

We held a conference, when we started the company in ’63, of all the people using analog computers, and quite a sizable group came. But five years later, when we had a second conference, only four or five came. It was dying.

COHEN: It was finished.

MACNEAL: It was dying by 1970. I don’t know what happened to the computer at Caltech in the Analysis Laboratory, but it was moved out of that room and moved somewhere else.

COHEN: So that was really the end of that, too.

MACNEAL: That’s right. It was the end of that. Between 1950 and 1960, it was the premier best way to solve these aircraft flutter vibration problems, and other structural analysis problems of that sort. But by 1970, the digital computer had taken over. So there was maybe a fifteen-year period when it was in its prime. It was really a very useful kind of thing.

COHEN: Do you know what McCann continued doing at Caltech after ’60?

MACNEAL: He got into digital computers. Of course, we all did. He was interested in a fly’s eyes, as I recall—in measuring their reactions to lights and things.

COHEN: You’re talking about flies—the insects?

MACNEAL: The insects—little flies. I wasn’t too aware of what his work was.

COHEN: Have you had much connection with Caltech over the years?

MACNEAL: Not much.

COHEN: You haven’t become an associate or anything?

MACNEAL: Oh, yes. I am an associate. Nobody ever asked me to join the board of directors.

COHEN: You're probably not alone in that.

MACNEAL: Well, I guess there are quite a few people who never were asked. [Laughter] But I would have thought, after MSC [MacNeal-Schwendler Corporation] went public and we had some money, that they'd start coming around, that they'd recognize that here was a graduate who had the potential to provide a little money. But they never did.

COHEN: It's certainly their loss.

MACNEAL: Well, yeah. Of course, they were going after Gordon Moore and a few other big guys. [Laughter] But their development organization could do a better job, I think.

It's important that people know that the analog computer was a useful computer. It could do things at the time that seem trivial today but that the digital computers of the world were not yet able to do. It filled an important role. It perhaps is unfortunate that Caltech in 1947 made a poor choice. They decided to support McCann in the analog computer, when the future belonged to the digital computer. It set them back a generation.

COHEN: It set Caltech back a generation?

MACNEAL: Yes, because their computing started in, what, 1975, or something like that?

COHEN: That's right.

MACNEAL: Well, if they'd started in 1950, think about how much further ahead they would be. Caltech would be known now as a much stronger force in the computer world than they are. But you can't tell—you make your—

COHEN: Well, the people at Caltech who are going to do it are the ones who make the decisions. That's the strength of the place.

MACNEAL: Somebody decided that they needed somebody in computing, and so they went and got Dr. McCann, because Dr. McCann was a former student. He got a PhD degree at Caltech [in

electrical engineering, 1939], and they knew about him and he was in computing. As far as they were concerned, computing was computing; whether it was analog or digital wasn't that important.

COHEN: Well, I think that has not been a real strength at Caltech anyway—the development of the computer science lab.

MACNEAL: No. But it could have been, if they had started with it a lot earlier, as so many other organizations had, like the University of Pennsylvania, where the ENIAC [Electronic Numerical Integrator and Computer] was developed. The ENIAC was developed for Aberdeen Proving Ground to replace the Bush differential analyzer, which was an early analog computer. Some of the guys in my outfit were sent up to Philadelphia to work on that. If I had been sent up to Philadelphia, I could have lived at home. [Laughter] How about that? I might not have married Carolyn!

COHEN: "What ifs" loom very large, but that's not how it goes. [Laughter]

MACNEAL: But that was an amazing thing. So anyhow.

COHEN: That's how it goes. **[Tape ends]**