THE BECKMAN CENTER FOR THE HISTORY OF CHEMISTRY

FRANCIS O. RICE

Transcript of an Interview
Conducted by

John A. Heitmann

at

South Bend, Indiana, and Mishawaka, Indiana

on

4 and 5 January 1984

Francis O. Rice

JH
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CENTER FOR HISTORY OF CHEMISTRY ORAL HISTORY PROJECT

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Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
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FRANCIS O. RICE

1890	Born in Liverpool, England, 20 May

Education

1911	B.Sc., chemistry, University of Liverpool
1912	M.Sc., chemistry, University of Liverpool
1916	D.Sc., chemistry, University of Liverpool

Employment

1919	1851 Exhibition Fellow, Princeton University
	Chemistry Department, New York University
1919-1920	Instructor
1920-1924	Assistant Professor
	Chemistry Department, Johns Hopkins University
1924-1926	Associate
1926-1938	Associate Professor
1938-1959	Professor and Head of Department, Chemistry Department, Catholic University of America
1959-1962	Professor and Chairman of Department, Chemistry Department, Georgetown University
1962-1968	Visiting Research Professor and Principal Research Scientist, University of Notre Dame
1968	Principal Research Scientist, Institute for Cooperative Research, Johns Hopkins University
1968-	Director, Research Chemistry Lab, Johns Hopkins University

ABSTRACT: Francis O. Rice discusses his life and career in this interview. He begins by mentioning his early days in England, his studies at Princeton, and his teaching at New York University. The interview elucidates Rice's teaching, research, and administrative activities at the Johns Hopkins university and the Catholic University of America. Of central concern is Rice's theory of free radicals. Mrs. Katherine Rice contributes to the interview by discussing her husband's professional activities and remembering several of his closest colleagues. The interview concludes with an appraisal of the place of science in Catholic universities and an explanation of the Laidler-ADX controversy of the mid-1950s.

INTERVIEWER: John A. Heitmann holds a bachelor's degree in chemistry from Davidson College and a master's degree in history from Clemson University. From 1974 to 1979 he worked as a chemist in the metallurgical industry. He then studied at the Johns Hopkins University under Owen Hannaway and received his doctorate in the history of science in 1983.

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DATE:	January 4 and 5, l984

Heitmann: I'm with Dr. Francis O. Rice in South Bend,Indiana. I'm going to interview him today in his office and tomorrow at his home. Dr. Rice, I know that you were born in l890 in Liverpool. Who were your parents and did you have brothers and sisters?

Rice: I come of Irish stock. My father was born in the north of Ireland; my mother was born in the south of Ireland. They met in Liverpool where I was born and educated. As far as I'm concerned I'm English. My father's people were farmers in Ireland. Due to troubled times there they emigrated, as did my father. He had some job on the railway in Liverpool. After he retired my parents moved to the north of Ireland.

Heitmann: Was he educated in a university?

Rice: He had very little education. He recognized that I had an interest in chemistry, however, and he did all that he could to encourage me to study it. He even allowed me to have a laboratory in our home when I was a boy. It's now almost a century since those days and I have no memory at all of what I did there. I doubt it was anything of any importance at all.

Heitmann: Did your mother also encourage you to do chemistry?

Rice: No, I have no recollection that she had any knowledge of it.

Heitmann: Do you have brothers and sisters?

Rice: I was the eldest in the family. I have a younger brother if he's alive. I've lost touch with him. His inclination was towards mathematics. He taught mathematics in a high school in Manchester. I also have two sisters. One is married and one is not. They live in our home, or what was our home, in Ireland.

Heitmann: Where in Ireland?

Rice: About six miles south of Armagh which is the capital of

Northern Ireland, I think. It's a historic little town. Our home was right on the border between Ulster and the Free State, although technically in Ulster. I think I have a picture someplace of the house.

Heitmann: How did you get interested in chemistry at such an early age? Were there any magazines that you read or was it just the times?

Rice: I simply don't remember. In the high school we had a course in chemistry taught by a man named Udall. I was a prize student.

Heitmann: This was in Liverpool?

Rice: In Liverpool.

Heitmann: We talked about your home laboratory a bit and how your father encouraged you.

Rice: My family are farming stock and the only thing I remember at all of any kind of gift in my family was my father's work with a machine. A neighbor bought it. It was for cereal.

Heitmann: A kind of mill?

Rice: Yes. Cereal came out at one end and waste at the other. No one could get it to function until my father worked on it. That's the only thing I remember. Apparently I did inherit something of that.

Heitmann: You did all your studies at the University of Liverpool. Is there any reason why you chose to go to Liverpool?

Rice: Well, in England there were two major universities, Oxford and Cambridge. There were also four northern universities: Leeds, Manchester, Liverpool,and Sheffield. Since I lived in Liverpool and the university was in the town, I went to Liverpool. I remember looking at the papers one morning on the way to school to see which of them made the most telling statement about a great piece of news. I decided that the Liverpool Mercury had. The statement was, "Titanic Founders with l800 Souls"--nothing more than that.

Heitmann: Who was your chemistry professor at Liverpool?

Rice: I think E. Baly, in spectroscopy, was my major professor. A man by the name of Henry Bassett was also there, as was F. G. Donnan.

Heitmann: What type of research did you do there?

Rice: Oh dear, I don't remember.

Heitmann: Do you have any other memories of Liverpool?

Rice: I won a scholarship to Liverpool and at that time I had no doubts that I wanted to go into chemistry. Of course I got my B.S. degree, my M.S. degree, and my D.Sc. in chemistry. At that time the D.Sc. was a higher degree in the sciences than the Ph.D. You had to distinguish yourself in science to be granted it.

Heitmann: I guess World War I started right when you were in graduate school.

Rice: I was really fortunate that a good deal of the research that I had done was on TNT.

Heitmann: It must have been about l9l6 when you started this work.

Rice: No. I did the work at the university after the outbreak of war in l9l4. I had to do a lot of travelling. At that time I went down to London and went into Officer's Training School. Before I was called for active duty a famous physicist was shot at the front and the British Government suddenly realized that, as they put it, they could not afford to use their scientists as cannon fodder. Accordingly, I was assigned to the Ministry of Munitions in l9l6. They had to build plants and I was sent round to be a chemical advisor because a good deal of my earlier research was on TNT. I knew a good deal about it. People think of it as a very dangerous thing. It's not a dangerous substance at all, except under special circumstances.

Heitmann: You became a theoretical chemist, but you had some very practical experience.

Rice: Oh yes. In the war. I worked on explosives.

Heitmann: Did you do any designing of machinery and apparatus?

Rice: No, that was more of an engineering thing. The engineers, you see, were very good.

Heitmann: And you were involved in managing.

Rice: Yes, rather soon I became the manager of H. M. Factory Bradley.

Heitmann: This was in Liverpool?

Rice: That was in Yorkshire.

Heitmann: Well, when World War I ended you came to this

country.

Rice: In l9l4 I had won a very valuable travelling fellowship. It's called "The 1851 Fellowship." I still have a letter from Professor Rubens from somewhere in Germany saying that he would be delighted to receive me as a student. By great good luck I had not gone to Germany before the war broke out. At the end of the war I therefore still had my travelling fellowship. Understandably, a beaten and impoverished Germany was no longer the place to go for postdoctoral study. Hugh Taylor, a fellow student who had gone to the U.S., said, "Why don't you come to the U.S. on your fellowship." I did.

Residents of both countries speak English, although sometimes the words have different meanings. At Princeton I once wanted a particularly long kind of a screwdriver and I wanted to know where an ironmonger shop was. Nobody had ever heard of such a thing. What I had wanted was a hardware store. If you ever go to England don't go talking about a hardware store. You want an ironmonger shop.

Heitmann: Can you remember your first impressions of this country? I know it's long ago.

Rice: Yes. l9l9 is long ago! I went to Princeton because Hugh Taylor was a personal friend of mine. He was on the faculty at Princeton. The Princeton chemistry department was not very strong at that time.

Heitmann: What were Taylor's research interests?

Rice: He was a physical chemist interested in how fast a reaction went and how it was affected by the changing temperature. The speed of reaction varies very markedly with increasing temperature and I was interested in knowing whether accurate measurements of the speed of a reaction could be duplicated elsewhere provided the temperature was the same. This proved true. I was one of the first people to prove that.

Heitmann: You were at a critical juncture when physical chemistry became joined with organic chemistry.

Rice: We called it physical organic chemistry. Chemistry was divided at that time among people who hardly knew each other, organic chemists and physical chemists. Organic chemistry was not physical chemistry. That is no longer the case at all.

Heitmann: So you went to New York University in l920.

Rice: Yes, in l920, when NYU offered me an instructorship. A year after that I was made an assistant professor at NYU.

Heitmann: You stayed there for four years.
Rice: That's right and those were very happy years. The head

of the department at the time was a man named Arthur E. Hill. He wasn't an elected head; he was appointed head of the department. But he was a very fair-minded man. For example, when a student went to him to ask his advice about choosing a doctoral thesis topic, he would ask the student what he was interested in. Usually the heads of departments took most of the students, but Hill didn't do that. He divided up the students with the men in his department. Much of my early research on measuring speeds of reactions was done at NYU. It gave me an opportunity to go to Hopkins, which was, of course, an advancement.

Heitmann: Do you remember any of that early work?

Rice: All of the work I did there had to do with precise measurements of reaction rates. There were good people there. I remember Kilpatrick who was a student of mine, and a man named Scott Lemkin who became a teacher of chemistry at a high school. His name is probably not in the American Men of Science, but that was in the early days.

Heitmann: What courses did you teach?

Rice: Ten or twelve hours of teaching is a pretty heavy load. Most people want a light teaching load, but I had a ten or twelve hour teaching load in New York University. Hopkins made this offer to me and my teaching load was too high. You may say, ten hours, what do you do with the rest of your time? Well, it's at least an hour of preparation for each teaching hour. Then you've got to discuss problems with your students; that's another two or three hours a day. So, if you have a schedule of ten hours a week, you've got nearly a forty hour week. You're kept pretty busy. At Hopkins I came ultimately to have only two hours of teaching per week.

Heitmann: Who was the department chairman? Do you remember?

Rice: J. C. W. Frazer was then the department chairman at Hopkins.

Heitmann: Was he a physical chemist?

Rice: Yes, I would call him a physical chemist. W. A. Patrick was there. Of course, he made a lot of money with his...

Heitmann: We'll get back to him. Was Emmet Reid there?

Rice: Emmet Reid.

Heitmann: Was Paul Emmett there? He may have come later.

Rice: I remember the name, Paul Emmett.
Heitmann: Well, it's not important.
Rice: Hopkins in the very early days was essentially a

graduate school.

Heitmann: It still is, although not as much.

Rice: Not as much. It gives bachelor degrees now, and there's a considerable college as well as the university proper. I had no connection at all with undergraduates. I taught for two hours and then advised research students. All the remaining time was mine for my research. I was at Hopkins for...

Heitmann: Fourteen years.

Rice: Fourteen years. l924-l938.

Heitmann: What did you teach in the two hours? Did you teach a course in kinetics?

Rice: Well, essentially some kinetics of reactions. When you taught only two hours in your own field you had hardly anything to prepare. So, I was free to do research work and see students. I didn't leave Hopkins and go to Catholic University because I was overworked; rather, I was lured by the salary, which was unheard of at that time, seven thousand dollars per year. My monthly salary at Hopkins had been two hundred and forty dollars which, of course, had to be augmented with consulting work.

Heitmann: Going back to Hopkins. Did the faculty have a sense that it was the great department of chemistry in this country? Did you all have a sense that it was falling from the top rank during your period? Do you think it was still one of the great universities in chemistry?

Rice: Yes, oh yes. The reputation of Johns Hopkins. Actually, I should have stayed at New York University. But the name of Hopkins attracted me.

Heitmann: Going back to the early work you did at Hopkins; it was on reaction rates.

Rice: Yes.

Heitmann: One of the things I was wondering about was whether the first book that you published, The Mechanism of Homogeneous Organic Reactions, was based on your lecture notes or on your course? It came out around 1928 and was an American Chemical Society monograph.*

Rice: It was based on my research work although, of course, my lectures were based on my work.

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*Francis O. Rice, The Mechanism of Homogeneous Organic Reactions from the Physical-Chemical Standpoint, (New York: The Chemical Catalog Company, Inc., 1928).

Heitmann: Did someone from the American Chemical Society ask you to write the book?

Rice: I don't remember. All I remember is that free radicals were supposed to be nonexistent. Chemists claimed that there were no such things as OH and CH and CH and CH in the free state. I was, I suppose, one of the first who showed that they did exist and that they directed the course of chemical reactions. Of course, I was very fortunate then in contacting Herzfeld. I'm trying to remember how I contacted Teller.

Heitmann: I guess that you really began to seriously investigate these things called free radicals in the late twenties. Did you initially start by reading the papers of a German chemist? What was his name?

Rice: Paneth?

Heitmann: Paneth? Did you start reading his papers? Copying his apparatus?

Rice: Essentially it was the method of Paneth and Hofeditz. My wife and I were in Heidelberg in l932-33 and we arranged to meet Paneth in Berlin for about a week. Paneth came from the eastern part of Germany especially for our conference.

Heitmann: When were you married?

Rice: l930.

Heitmann: Was your wife a student at Hopkins?

Rice: My wife always wanted to be a physician. After she graduated from high school her father didn't want her to go directly into a premed course. In 1922 no medical school in the U.S. required more than two years of premed studies. Her father, who was a professor of mathematics at the University of Illinois, said that she should have at least four years of liberal education and then go on to earn a doctor's degree in any field in which she qualified. He said, "No daughter of mine is doing to grow up in a medical school. If, after you have a Ph.D. you still want to go to medical school, I will do all I can to help you." So she took her doctor's degree with E. V. McCollum in biochemistry, with the idea of then going into medical school.

There was a wife of a professor in the math department who was a matchmaker. She knew my wife's family from math association meetings. (My wife's father had been President of the American Mathematical Association.) So, when Katherine came to Baltimore in l928 on a fellowship to McCollum's department, this lady told her that there were two bachelors on the faculty of Johns Hopkins University and that she should marry one of them. One of the men was J. C. Hubbard, a physicist. I was the other.

Heitmann: Your wife chose psychiatry as a profession.

Rice: Yes.

Heitmann: Was this later? I know for a while she was writing books with you.

Rice: That was between our marriage in l930 and the birth of our second daughter in l936. She worked with me and then she became head of the chemistry department of the College of Notre Dame, Baltimore, from l933 through l936. We thought that she might become a chemist, but she is essentially a physician. Actually, my wife didn't go to medical school at Johns Hopkins until after the birth of our second daughter. She finally got into the field of psychiatry, although she had originally thought to go into endocrinology. She put in two years as a research assistant to Curt P. Richter, whose psychological-endocrinological research was being conducted in the Phipps Psychiatric Clinic at Hopkins Hospital. It was obviously what she wanted and she was good at it.

Heitmann: Getting back to Hopkins again. Walter Patrick did some outside consulting. Did other professors do consulting at Hopkins or was Patrick pretty much an exception?

Rice: No, we all had to supplement our university salaries.

Heitmann: Did you do some consulting?

Rice: Yes. I did consulting. All of us did some consulting. Often our consulting income was greater than our university salary.

Heitmann: For whom did you consult?

Rice: A firm called Rohm and Haas.

Heitmann: Oh yes, of Philadelphia.

Rice: Of Philadelphia. Mr. Haas was the president. I had contact with him and I used to spend one day a week at his place in Philadelphia.

Heitmann: Do you remember what you were working on at Rohm and Haas? Was it polymers? Of course, plexiglas came out in l935.

Rice: I don't remember.

Heitmann: It's a hard question. Of course you collaborated with Herzfeld and Teller. You knew Herzfeld in your day to day life at Hopkins. Do you have any memories of him?

Rice: Oh yes, we were close friends soon after he came to the

Hopkins Physics Department around l926. He was best man at our wedding and he was the godfather of our oldest daughter.

I had been interested in speeds of reaction. Because a free radical initiates a complicated chain of reactions, I proposed a complicated mechanism to explain the reactions. Herzfeld, who was primarily a theoretical scientist and who had never done an experiment in his life, showed that these reactions followed a simple law in spite of their complexity. His doing that greatly helped me to get other scientists to accept my hypothesis. Herzfeld knew no more chemistry than the average physicist, but he was very good and so was Teller. I was very fortunate in making contact with both of them. Teller is a Hungarian, and of all the countries in Europe, Hungary is the nearest to England in outlook.

Heitmann: In l938 you went to Catholic University at, I guess, an improved salary.

Rice: Salary was one reason. Another was that I am a Catholic and I welcomed the opportunity to help upgrade the quality of the science program at Catholic University which at that time was not very good. I was fortunate to be a close friend of Archbishop Curley, archbishop of Baltimore and Washington. Through the Archbishop's introduction, the rector of the Catholic University asked me to make a survey of the chemistry department at Catholic University. I was also to suggest what changes would have to be made in order to make Catholic University one of the leading chemistry departments in the United States. That was in l936, I think. After I handed him a devastating report, essentially recommending dismissing all but one of the faculty, he offered me the job of fulfilling his assignment. So in September, l938, I went to the Catholic University in Washington, D.C., not as an elected department chairman, but rather as the appointed head of the department--which is quite a different thing.

At that time, many of the people on the faculty had gotten their degrees from Catholic University and had never studied anywhere else. I wanted to change that tradition. I required that every faculty member in my department study at the graduate level or teach for at least a year at another university. By doing that, I was able to build a very strong department.

Heitmann: You knew Archbishop Curley when you were a professor at Hopkins in Baltimore, is that right?

Rice: He was the Archbishop of Baltimore and Washington, I think.

Tweedell: Didn't he perform your marriage ceremony?

Rice: My wife is not Catholic so we were married at the archbishop's house in Baltimore. When you're not of the same religion you do have to be very careful that you're married properly.

Heitmann: Until very recently, Catholic institutions weren't very strong in the physical sciences. Is it changing now?

Rice: Yes.

Heitmann: Do you have any thoughts about that?

Rice: Yes. In part, the weakness was caused by a prejudice against biological science. You see, the biblical story of creation, as far as science is concerned, is a lot of poppycock. But there is no prejudice at all against the physical sciences.

Heitmann: Karl Herzfeld also went to Catholic University, didn't he?

Rice: Yes, he did. Karl was Catholic too. I was close to him. Karl had a considerable edge on me. He proved that the complicated mechanism that I had devised was in disagreement with the older simpler arrangement.

Heitmann: When you came out with this very unusual interpretation of how organic materials come together and react, were you supported or opposed? Did other scientists care? Did they think that it was just another crazy idea.

Rice: Certainly.

Heitmann: Had you a lot of graduate students at Hopkins?

Rice: Not very many. The system there was not very good. When a student was ready to initiate his research for his doctoral dissertation, it was mandatory that he talk with every faculty member. He was perfectly free to choose to work with any of them. I don't believe that was always a good system, but they prided themselves on their great freedom there. Of course, it meant that a man like Patrick who had a successful practical venture had a lot of students.

In l924, when I went there, the administration added three young men. One was a man named Bichowsky; the second was H. C. Urey, the Nobel Prize winner; and I was the third. Bichowsky died about l950.

Heitmann: What was his field?

Rice: Bichowsky was a remarkable man. His field was the whole world.

Heitmann: Including the arts?

Rice: Oh yes. He painted. He had no religion of any kind. One time, my wife and I, with Bichowsky as our guest, were at our cottage on the Chesapeake Bay. We went to Mass and he spent the time making a painting of the cliff and beach below our cottage. The reason why he is not now remembered is

because he went in every direction. He left Hopkins. He went to Columbia.

Heitmann: Did any companies, like GM, recognize the significance of your work?

Rice: I don't think so. It was generally believed that free radicals didn't exist.

Heitmann: One of the great problems during that period was the production of tetraethyl lead. The Ethyl Corporation was getting started and Thomas Midgely was working on these problems. You were right in the middle of a very big thing commercially.

Rice: I didn't recognize that at the time. I remember I took out some patent or another and wrote to the Du Pont Company to ask whether they would be interested. Boy, were they down quickly. But they were afraid...

Heitmann: You didn't have any contact with Carothers?

Rice: No, I don't think I knew him. I think Carothers died quite young.

Heitmann: He was about forty, I think. He was in Baltimore for some time because he received psychiatric treatment at Johns Hopkins. Hugh Taylor was also at the top of something commercially, that was polyethylene. He made polyethylene in the laboratory and never really recognized just how commercially significant it would become. I have also noticed, while looking at your papers, that a number of your graduate students had been supported by fellowships from Du Pont and GM. That was one reason why I wondered whether or not companies had expressed some interest in supporting your research.

Rice: There was a an extraordinary chap at the department named Neil Gordon. He used to go around to different maufacturers and say, "We're educating the wrong kind of man. We should have State Fellows, that is, the best students from all the different universities in North Carolina. We should then send them to Hopkins for four years, pay them a big stipend, and give them a doctoral degree." He got a lot of money for the chemistry department from different chemical organizations. Of course, the companies were not completely altruistic. I suspect that the students who received the doctorates then went to work for them.

Heitmann: You and Glasebrook published a very important paper.*

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*Francis O. Rice and A. L. Glasebrook, "Thermal Decomposition of Organic Compounds from the Standpoint of Free Radicals XI," Journal of The American Chemical Society, 56 (1934): 2381-3.

Rice: That's right. I think it was on the bivalent carbon...

Heitmann: Carbene.

Rice: Carbene. There was a big argument then on whether or not they were stable. The two oxides of carbon, the CO and CO , are both stable; but what about CH , is that stable? I think it's pretty well settled now that it isn't. It has a short life.

Heitmann: During your last few years at Hopkins you and your wife did a lot of work together. The two of you wrote a book on free radicals.* Several of your children were born in Baltimore during those years. Did your wife work in the laboratory? Did she help you with the writing?

Rice: For a while she worked in the laboratory. For a while she also helped me a good deal with the writing.

Heitmann: She had an appointment at Notre Dame College, didn't she?

Rice: She was on the faculty at Notre Dame.

Heitmann: You went to Catholic University in 1938. Did you do any war work after World War II started?

Rice: Yes, I did do some.

Katherine: The day that war was declared, Frank cabled the British Ministry of Munitions and asked whether they wanted him back. This was the last thing on God's earth that they wanted. They were afraid of being blockaded by U-boats. They were trying to get people out of the country and therefore did not want Frank Rice back there. They suggested to him that he work on chemical warfare with the Americans.

During World War II therefore, he not only taught at the Catholic University, but he also served as a consultant to the federal government, advising about chemical warfare. He was a "dollar-a-year" man. At first, the government sought advice about the disposal of the byproducts of munitions plants. There were no considerations about the disposal of nuclear waste at that time. Frank chaired a committee. He and his colleagues would visit various sites. As an Englishman, however, he didn't have total clearance. Often, the other men would look over the situation and report to him in great detail. He was the only one of the group who had had any experience in this field, having worked with munitions during the first World War.

Frank continued to teach during the war or we wouldn't have had any income. I think that all of the "dollar-a-year" men had independent incomes. The government didn't take

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*Francis O. Rice and Katherine K. Rice, The Aliphatic Free Radicals (Baltimore: The Johns Hopkins Press, 1935).

full-time people and call them "dollar-a-year" men.

Heitmann: At any rate, you continued your research with free radicals?

Rice: Oh yes.

Heitmann: And you actually went in different directions with the free radicals at Catholic University, trapping them at low temperatures?

Rice: Yes.

Heitmann: You also prepared new types of free radicals as well.

Rice: Yes. I think at about minus a hundred and seventy. I wanted to find out if they were reasonably stable. I haven't found any as yet. It may very well be that the gasoline of the future will be a very cold gasoline so that you could get half way across the country using only about twenty gallons. It's quite a possibility. That's what I'm working on now in the laboratory. It's a curious thing that the U.S. is not an oil rich country. We import quite a bit of it.

Heitmann: So you're trying to apply your ideas about free radicals to alternative energy sources?

Rice: Yes.

Heitmann: In 1959 you retired from Catholic University and went to Georgetown.

Rice: I could have retired from Catholic University when I was sixty-five. I had to retire when I was seventy. So, I went therefore to Georgetown.

Within three months of commencing my work at Georgetown as a research professor, I was asked to become temporary director of the chemistry department. I accepted the appointment for a three year term. I left Georgetown in 1962 because I wasn't getting along very well with the dean of the graduate school and because a former student of mine, Milton Burton, got Notre Dame to offer me a job. Of course, when you're seventy-two and someone offers you a good academic job, you accept it, even if it is in the Midwest. So, that's how I ended up at Notre Dame. I was on the faculty in the chemistry department for six years. I retired then. Now I do some independent work.

Heitmann: Did you teach any courses at Notre Dame while you were there?

Rice: No. I had a very grandiose title, Professor of Chemistry and Principal Research Scientist at the Radiation Laboratory. I held that position for six years before

retiring and building a laboratory in my home. At that time we had a private house. Of course, when you're living in a house, the roof leaks or the grass has to be cut; so five years ago we moved here and we have these two adjoining apartments. These are two units with two kitchens. I made one of the units into a laboratory.

I still think that free radicals may be of use in the practical world. The only thing that I have to do is to get a source of free radicals that's very cheap and plentiful and that will last. Many free radicals are stable at liquid nitrogen temperatures. Because they are, there is a possibility that they will be the fuel of the future. It will be about four times more powerful than the best gasoline you can buy.

Heitmann: You're still very active.

Rice: Oh yes.

Heitmann: You have seen chemistry change from being almost a brand new profession to becoming an integral part of our society. What do you think was central to chemistry's changing?

Rice: Let me think about that and answer tomorrow. Let me also think about what chemistry is likely to become when none of us are around any more.

Heitmann: There are a number of questions we will discuss tomorrow with your wife. Perhaps now I could take a picture of your apparatus.

Heitmann: I am now at Dr. Francis Rice's home in Mishawaka, Indiana. I shall initiate today's interview by asking Mrs. Katherine Rice some questions. Mrs. Rice, you attended the University of Illinois as an undergraduate?

Katherine: Yes. My father, an Englishman, was on the faculty of the University of Illinois. He was a mathematician and had gotten his degree at the University of Gottingen in Germany. At that time Gottingen was the mathematical center of the world.

Heitmann: What was your maiden name?

Katherine: Kempner. After my father got his doctorate at the University of Gottingen, when I was about four or four and a half years old, he wanted to settle in an English-speaking country. Going back to Britain wasn't very practical, however, if he wished to advance himself professionally. So, he didn't go back to England. He had offers from Brown University and the University of Illinois. I don't know if he had any others. We settled in Illinois and I grew up there. In 1925, or two years after I had enrolled at the University of Illinois, my father got an offer to head the mathematics

department at the University of Colorado. Although I wanted to stay at Illinois, I was yanked away from there and taken to the University of Colorado. But it turned out that I got a much better education there. I was one of only two biochemistry majors.

Heitmann: After you finished at Colorado, you went to Hopkins.

Katherine: Yes. I got a scholarship to work under McCollum and got my doctorate there in biochemistry.

Heitmann: How did you meet your husband?

Katherine: Through a matchmaker, the wife of a math professor at Hopkins. He knew my family and I had met him in Boulder one summer.

Heitmann: You husband was telling me that this morning. A mathematics professor.

Katherine: Professor Cohen.

Heitmann: Cohen?

Katherine: Yes, Cohen. I don't remember his first name. He was at Hopkins on the college math faculty and my father had employed him one or two summers in Boulder. Mrs. Cohen was an inveterate matchmaker. Shortly after I got to Baltimore she called me and said, "I've got two men you have to meet. You've got to marry one of them." She said, "One of them is Charles Hubbard in the physics department and the other is Frank Rice in the chemistry department. One of these two has to be just right for you." She didn't know me very well, but I guess she knew me better than I thought she did. Well, all that year she was so busy getting her own daughter married that she couldn't ever get around to it. Finally, Mrs. Cohen called. She told me that Charles Hubbard had gotten married. "But," she said, "I've got to have you meet Frank Rice in a hurry now so that nothing will happen to him." So, on November 1, she set out a four-table bridge party. Mrs. Cohen made a very big thing of the fact that Frank and I had each just moved into new apartments. At that time, I was a graduate student and he was a tenured associate professor.

After the bridge party Frank offered to take me and a friend home. Well, we dropped my friend off and then I invited Frank to come to my apartment. He looked at me absolutely scandalized! This was probably 12:30 a.m. I assured him that in East Baltimore that was quite acceptable. We often worked in the laboratory until 10:30 p.m. or 11:00 p.m. and would adjourn to one or another's apartment, sometimes in couples, sometimes in threes, to have some cocoa or tea. I told him that even if he were seen coming out of the house where I live his reputation would be quite safe! So he came upstairs with me.

Heitmann: Did you visit Frank at his laboratory quite frequently after that?

Katherine: Oh, I saw him very often after that but not very much in the lab. On November l0 he had asked me to marry him! This from a man who had never been married, or even engaged, and who was over thirty-nine years old. He was very sure of himself.

Heitmann: Was Edward Teller...?

Katherine: Was he paranoid when I knew him?

Heitmann: I didn't want to ask the question like that, but that's about right.

Katherine: No. I did not notice a paranoid tendency until he attacked Oppenheimer. I thought the obsessive preoccupation with the Russians was understandable because he had had a horrible and dramatic escape from Hungary to get to this country--walking long distances and so on. Terrible, terrible situation. But I've known other people who have had similar horrible experiences and I've finally concluded that such situations either make one extremely bitter and paranoid or an exceedingly tolerant person.

Heitmann: Frank was also really close to Herzfeld?

Katherine: Oh very true. Frank came to Hopkins in l924 and I think Herzfeld came to lecture in 1925. He was invited either to come back or to stay. Karl was best man at our wedding and our oldest daughter's godfather. Frank and Karl had a close friendship which I soon shared. Less than a year later Joe and Maria Mayer came into the department and the five of us had a very good relationship. Karl wasn't married then.

Heitmann: Did Karl ever marry?

Katherine: Yes. I remember the time he called and told me that he was going to marry Regina Flanery. Eventually, Karl left Hopkins and went to Catholic University as head of the physics department.

Heitmann: He was a very good physicist.
Katherine: He was an outstanding physicist.

Heitmann: The interesting relationships are the relationship between Frank and Karl on the one hand and with Teller on the other hand. Was the collaboration different?

Katherine: Yes, the two relationships were different, very different. Scientifically Karl did a great deal for Frank's theory.

Heitmann: I think it was l938.

Katherine: Probably l938. That changed the attitude of scepticism, if not of ridicule, which this theory of free radicals as involved in the pyrolytic decomposition of organic compounds had engendered. For years chemists had been teaching that there are no such things as free radicals. Along came Frank who said that every heated organic compound starts to decompose and produces free radicals.

Heitmann: I asked Frank this question, and I want to ask you as well. During the ten years when Frank proposed this idea and it really wasn't accepted, did he have supporters on the one hand and violent detractors on the other?

Katherine: Oh yes. There were more detractors.

Heitmann: Can you think of any?

Katherine: Well, Hinshelwood was the leading detractor. He had an opposing theory which I can't recall at this time, but he absolutely denied the free radical theory of small percentage decompositions. Hinshelwood got the Nobel prize for that. Only two years later, Frank and Karl presented theoretical justification for the free radicals.* Hinshelwood had Frank's Nobel prize. I'm a little bitter about that. I would have liked Frank to have won the Nobel prize.

Heitmann: Did Frank and Hinshelwood ever meet?

Katherine: Oh yes. As far as I know they hadn't known each other in England. After he came to America, however, Frank went back to Europe for a few weeks during alternate summers. His parents were there and he wasn't married at the time. He certainly had contact with Donnan and E. Baly, who had taught him at the university. He also reestablished connections with one of the secretaries in the department. I'm sure that he contacted scientists while over there. I never thought to ask him whether he knew Hinshelwood until they clashed in the literature.

Heitmann: Were there any American detractors?

Katherine: The textbooks were all teaching that there were no such things as free radicals. So, in a sense, the teachers in both high school and college were detractors.

Heitmann: Did Frank have any contact with Hugh Taylor?

Katherine: Oh yes. Hugh Taylor and Frank had known each other at the University of Liverpool. Frank was the best

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*Francis O. Rice and Karl F. Herzfeld, "Thermal Decomposition of Organic Compounds from the Standpoint of Free Radicals VI," Journal of the American Chemical Society, 56 (1934): 284-9.

man at the Taylors' wedding and the godfather of their oldest daughter. She, in turn, is godmother of our youngest daughter.

Heitmann: What did Taylor think of Frank's ideas?

Katherine: He was supportive.

Heitmann: So he was really an American supporter.

Katherine: Yes, he really was. I don't think he published very much about it; he didn't make it a major issue. But I've heard Taylor give some addresses, for instance the one at Frank's seventieth birthday party, when he spoke about "an angel among fools."

Heitmann: Did he call Frank an "angel among fools"?

Katherine: Yes. Hugh Taylor never minced words. As a matter of fact, Hugh Taylor was responsible for Frank's coming to America.

Heitmann: Yes, he told me about that.

Katherine: I don't suppose that he lived with the Taylors, but he might just as well have been camping with them during his first year in America when he was at Princeton. After he accepted an offer from New York University, he still went to parties at Princeton. He would sometimes invite the Taylors up to New York City.

Heitmann: When you moved to Catholic University, did you move to the suburbs of Washington?

Katherine: Yes. We lived in a suburb of Silver Spring called Woodside Park.

Heitmann: While Frank was at Catholic University he spent a lot of time doing administrative work.

Katherine: Well, he was head of the department. I wanted him to stay entirely in research. He had had a marvelous appointment at Hopkins where he had done very little teaching. I think that he taught only one seminar each semester and advised his Ph.D. candidates. He was essentially a research professor. I had always held research in much higher regard intellectually and scientifically than teaching. Frank doesn't agree entirely with me on that. He won an award from the Manufacturing Chemists Association of America for being the best teacher of college chemistry in the United States.

Heitmann: Did he teach freshman chemistry?

Katherine: He taught freshman chemistry after he arrived at Catholic University. I thought that too was a waste, but he

said, "That's where I'm going to pick up my chemistry majors." And he was right. He was an outstanding teacher, beyond question. How he taught four hundred and fifty young people chemistry at one time is beyond me.

Heitmann: It's really difficult.

Katherine: But he did it and the quality of his teaching was very high.

Heitmann: But he kept on doing research, didn't he?

Katherine: He couldn't do much. Graduate students largely carried out his research. Before he became head of the department, Dr. Hardee Chambliss, the previous chairman, had had a very large and elegant office and an anteroom for his secretary. Frank immediately converted Chambliss' office into a library and greatly expanded the university's collection of chemistry books. He used the anteroom as his office. He also had his apparatus for free radical production placed on a large lab table and set in the space between the door and his desk. He did that so that he could work with it whenever he had some free time. You couldn't get in or out of his office without having to walk around the apparatus.

Heitmann: He showed me a picture of that.

Heitmann: Tell me more about Frank's scientific colleagues and his relationships with them.

Katherine: Bichowsky knew Frank before I did. Frank came into the chemistry department at Hopkins with two other young men, Harold Urey and Bichowsky. The three of them became good friends. They formed their own little clan at Hopkins because the older scientists set themselves apart from the much younger men. They were given both an inordinately large number of students to teach and the less precocious ones as well. The senior members took the cream off the top.

Heitmann: Frazer and Reid?

Katherine: Yes, especially Reid and Patrick.

Heitmann: Did Frank admire Urey very much?

Katherine: Oh yes, I think so. They were good friends. Harold left Hopkins first. The three of them came in l924 and Harold left in l927 or l928. Bichowsky left later to become director of the Naval Research Laboratory in D.C. He was also in kinetics. He is one of those supremely gifted people who have difficulty concentrating their energies upon one task. He's starred in Men of Science but he also worked with Porter Sargent on his murals in the Boston Public Library. Under a pseudonym, Bichowsky also composed a number of pieces of music. He also published some novels. One Sunday morning

while we went to Mass in St. Frederick's, he painted the picture of the cliff below our cottage. I was so enthusiastic that when he next visited late in the fall I asked him to paint the other scene.

Heitmann: Your years in Baltimore were pretty wonderful.

Katherine: Oh they were wonderful years.

Heitmann: Frank had mentioned something very interesting. I asked him how he got to Catholic University and he mentioned his connection with Archbishop Curley. Did Curley actually persuade him to go down there?

Katherine: No. Actually, the archbishop persuaded the rector of Catholic University to ask Frank to evaluate the university's chemistry department. Frank put it way down on the list of American chemistry departments. So, the archbishop asked him what would be required to make it one of the ten leading chemistry departments in the country and promised to provide him with substantial support for that purpose.

Heitmann: I asked Frank this morning about this. Until very recently, very good science just hadn't been done in Catholic institutions.

Katherine: I know.

Heitmann: A lot of reasons have been forwarded to explain this phenomenon. Is it the Church that's responsible or is it the social background of many Catholics? Do you have any thoughts on this matter?

Katherine: I think that both here and in Europe the Catholic population as a whole is not nearly as intellectually oriented as Jews and a great many Protestants. Catholicism is so important to Catholics and they're so sure that the Church has all the answers that they're not nearly as concerned about learning as research scientists have to be.

Heitmann: Did Frank have to overcome a lot of that kind of thought when he became chairman at Catholic University?

Katherine: He was told that he could hire any qualified person who applied for a position. If two people, one Catholic and one non-Catholic had the same qualifications, however, then he was to hire the Catholic.

Heitmann: He has played a very important role in changing the way that Catholic institutions regard science.

Katherine: Is that so? I didn't realize that. I knew that he changed the chemistry department of the Catholic University and that he had the support of Herzfeld who had moved a few

years earlier to the Catholic University and headed physics.

Heitmann: In the l950s Frank became interested in looking at wider problems related to free radicals: space on the one hand and the origins of life on the other.

Katherine: Yes, I think you're right.

Heitmann: Why did he turn away from the laboratory? Did he need to extend his work?

Katherine: I don't think it was that so much, as that he thought free radicals might have had something to do with the origins of life. I think it was a natural outgrowth of the free radical work. I don't know whether anyone has reported finding the spectra of free radicals in the sun's spectrum. There is methane in the sun. And I don't remember the chemistry involved, but I do remember it seemed a natural outgrowth of his previous work. Perhaps his friendship with Urey, who was thinking very much along those lines, also influenced his outlook.

Heitmann: I think he was a great, creative scientist and that his insight into organic reactions was phenomenal.

Katherine: I couldn't agree more wholeheartedly.

Heitmann: (To Dr. Francis Rice) You were involved for quite some time in studies on a battery additive, ADX . I was wondering if you want to talk about that today. Was it Jess Ritchie who invented the substance?

Rice: He invented it. I don't know what Ritchie's history was. He was not a scientist at all, but he invented a substance named ADX . When a car battery went dead, one popped in a little package of ADX .

Heitmann: Don't they still sell that?

Tweedell: I don't think so. There was a big government investigation of it.

Rice: Oh, don't say that. It turned out to be a rare chemical with the formula NA SO , which cost about ten dollars a ton. (laughter) He was selling a little package for three dollars. It was nothing but sodium sulfate. I think it was in Boston.

Tweedell: I think it was MIT.

Rice: MIT and the Catholic University. By the way, do you happen to have a copy of that letter we wrote to the

Washington Post?* It got published.

Tweedell: I think we will find it. (Reading)

> Because of the recent publicity given to the subject of battery additives in which phrases have appeared, such as, "Scientists on the staff of the Massachusetts Institute of Technology and Catholic University" and "Tests by the Catholic University and Massachusetts Institute of Technology Scientists," it seems advisable to clarify the position of the undersigned members of the chemistry department of the Catholic University of America on this subject. At no time were experiments conducted here or elsewhere under the sponsorship of the Catholic University Chemistry Department. Any consultation on battery additives undertaken by an individual member of the Chemistry Department was performed as a private project and without the benefit or the advice or approval of the Department. In short, we have had nothing to do with the subject of battery additives and repudiate the implication that we endorse any of them.
>
> It is not our intention to enter into the controversy concerning the merits of battery additives in general or of ADX in particular but rather to affirm our faith and confidence in the scientific method as the only safe way of arriving at the truth in this matter.

Heitmann: How did Catholic University get involved in this?

Rice: Is there any more stuff about that? Wasn't there some speculation in the paper? In the Post, about...

Tweedell: Here are clippings.

Rice: You may as well read that too. He may as well know. It's hot stuff. You see, there was one member of the department who did endorse ADX .

Heitmann: Who was that?

Rice: Laidler.

Heitmann: Laidler endorsed it? When?

Rice: It should appear here.

Tweedell: l953. We have a whole book of newspaper clippings. The National Bureau of Standards got involved.

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*Alfred Friendly, "CU Experts Deny Battery Additive Tests," Washington Post, 17 April 1953, pp. 1 and 10.

Rice: Oh yes. The director got fired!

Heitmann: The Director of the National Bureau of Standards! It was probably, what's his name, Astin?

Tweedell: There were congressional hearings on it.

Heitmann: Did you have to participate in the congressional hearings?

Rice: No, I didn't actually. I walked out. This fellow Ritchie pours ADX into a battery and a lot of scientifically ignorant senators... (laughter) Oh my, hot stuff!

Heitmann: How did Laidler get involved in all of this? Did they approach him?

Tweedell: He was consulting for that firm, wasn't he?

Heitmann: Apparently Laidler and the laboratories at MIT endorsed this product. The National Bureau of Standards tested it, however, and found that it was worthless.

Rice: That phrase was, "It was without merit," I think.

Tweedell: Somehow, this became a political thing. Because he said it was no good, the chief of the NBS was fired. All sorts of people then jumped on the issue. Here's a whole book full of political cartoons.

Heitmann: Well, really Frank, you were in the middle of this.

Rice: That's so. Yes indeed. They said my department endorsed it.

Tweedell: Here's the article that includes the letter that I just read.

Rice: That's right.

Tweedell: Yes. (Reading)

> Seven members of the Chemistry Department at Catholic University yesterday disassociated themselves from their eighth colleague over his endorsement of the controversial battery additive ADX . In a statement bearing on the fight raging over the National Bureau of Standards' adverse tests of the substance and over the forced resignation of its director, the Catholic University scientists said they repudiated the wide-spread public impression that they endorsed any battery additive. They added that at no time were any of the experiments on the subjects conducted on the sponsorship of the university Chemistry Department.

> What experiments one of their number did on his own, they said, were without benefit or advice or approval of the department. Their statement was obviously in reference to the work of the eighth member of the university's Chemistry Department, Dr. Laidler, who has become one of ADX 's most energetic champions. Originally employed as a consultant by the manufacturer of the ADX , Laidler has since become the scientific advisor of the Senate's Small Business Committee, which has taken up the cause of the battery additive. It was learned yesterday that a year ago Laidler wrote a nine page report for Pioneers Incorporated, the Oakland manufacturer of ADX . The document, signed by Laidler, and bearing the date of May l5, l952, was copyrighted and distributed by Pioneers Inc. It is a glowing endorsement of ADX 's efficacy in prolonging the life of a storage battery and combatting deleterious effects of age and usage. It denounces tests by the Bureau of Standards which said that no additives had any such value. Since Laidler's association with the Senate Small Business Committee, that group issued a report alluding to favorable tests of ADX by "Catholic University Scientists." It was to this aspect of the situation that yesterday's statement referred. In a letter to the Washington Post, the Catholic University scientists made it clear that it was the expression of their own views and not an official or unofficial reflection of opinion of the institution, and the statement read..."

Heitmann: And that's the one you read me.

Tweedell: Yes.

Heitmann: Now, Laidler ended up going to Canada after this? Did he stay in the States somewhere?

Rice: Laidler was, I think, an associate professor. You didn't get tenure until you were a full professor. Anyhow, he was on a three year appointment. Because his endorsements got us into trouble, I recommended that his appointment not be renewed. Quite recently he wrote me a rather friendly letter.

Heitmann: Sometimes it's just best to let these things die. But it's a very interesting episode.

Rice: Oh yes. Well, I've always wanted to ask Laidler why he did it. He shouldn't have done it. The best thing you can say about ADX is that it didn't do the battery any harm.

Heitmann: I think it's a very interesting case of how science, consulting, and business all come together and sometimes create great problems. Laidler ended up writing a fairly good textbook on chemical kinetics.

Rice: I wrote a letter to him advising him to write a history of chemistry. I can hardly believe that Laidler would still endorse ADX .

Heitmann: Would you say that that was about the most difficult administrative problem you had in your career?

Rice: Yes. It was a very difficult period.

Heitmann: There is a question I wanted to ask you. Your academic career spanned fifty-one years. Looking back, can you think of any central achievement which you think transformed chemistry during your own lifetime?

Rice: Well.

Heitmann: Linus Pauling, do you think?

Rice: I really know too little about his work, but I came to America in l9l9. I was at New York University, then Hopkins, and then Catholic University. I was a year or two at Georgetown; then I came up to Notre Dame. I'm here now steadily working along.

Heitmann: What did you think of the work of Henry Eyring? He never won a Nobel Prize.

Rice: No. Very knowledgeable man in mathematics.

Heitmann: You say the idea of speed of reactions and chemical kinetics did a great deal to transform what we know as chemistry today.

Rice: I think that's right. The speed of chemical reactions. The mechanism of chemical reactions.

Heitmann: That was all new when you first started your chemical career.

Rice: Oh, yes. Of course, when I started work, E. Baly was my professor at Liverpool and his work was mainly spectroscopic.

Heitmann: I think I'll close the taping for now. Thank you for the interview, Dr. Rice.

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