THE BECKMAN CENTER FOR THE HISTORY OF CHEMISTRY

PAUL W. MORGAN

Transcript of an Interview
Conducted by

Herman Skolnik

at

West Chester, PA

on

15 March 1986

THE BECKMAN CENTER FOR THE HISTORY OF CHEMISTRY

Oral History Program

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PAUL MORGAN

1911 Born in West Chesterfield, New Hampshire on 30 August

Education

1937 B.S., chemistry, University of Maine
1940 Ph.D., organic chemistry, Ohio State University

Professional Experience

Ohio State University, Columbus, Ohio
1937-1940 Teaching Assistant, chemistry
1940-1941 Du Pont Fellow
E. I. du Pont de Nemours & Company
1941-1946 Research Chemist
1946-1957 Research Associate
1957-1973 Research Fellow
1973-1976 Senior Research Fellow

Honors

1959 Best Publication Award, Delaware Section, American Chemical Society
1976 Polymer Chemistry Award, American Chemical Society
1976 Howard N. Potts Medal, The Franklin Institute
1977 Elected to the National Academy of Engineering
1977 Best Publication Award, Delaware Section, American Chemical Society
1978 Engineering Materials Achievement Award, American Society for Metals
1978 Swinburne Award, Plastics and Rubber Institute of Great Britain
1978 Kenneth Hertel Lectureship, University of Tennessee
1979 W. H. Rauscher Memorial Lecturer, Rensselaer Polytechnic Institute
1979 Midgley Award, Detroit Section, American Chemical Society
1982 Honorary Member, The Fiber Society
1986 Delaware Section Award, American Chemical Society
1987 Whitby Memorial Lectureship, University of Akron
1988 World Materials Congress Award
1988 Carothers Award Lecture, Delaware Section, American Chemical Society

ABSTRACT

Paul Morgan starts the interview by describing his childhood in Maine and his family background, high school and early interests. After undergraduate studies at the University of Maine, Morgan did graduate research at Ohio State University on naturally-occuring plant pigments and continued with post-doctoral work on cellulose derivatives. He describes his Du Pont investigations of the synthesis of polymers, with particular emphasis on interfacial polycondensation. Incorporated into the interview are Morgan's reflections on scientific publication from an industrial setting.

INTERVIEWER

Herman Skolnik received the B. S. degree in chemical engineering from The Pennsylvania State University, and the Ph.D. degree in organic chemistry from the University of Pennsylvania. He joined Hercules, Inc. as a research chemist in 1942, and served as a divisional research manager from 1952 until his retirement in 1979. He was the founding editor of The Journal of Chemical Documentation, and has published over 200 papers and four books, including A Century of Chemistry, the centennial history of the American Chemical Society.

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INTERVIEWER: Herman Skolnik

LOCATION: West Chester, Pennsylvania

DATE: 15 March 1986

SKOLNIK: Dr. Morgan, I would like to have first your date of birth.

MORGAN: 30 August 1911.

SKOLNIK: And where?

MORGAN: In West Chesterfield, New Hampshire.

SKOLNIK: Did you live there through your high school years?

MORGAN: No. My family moved to Maine when I was seven.

SKOLNIK: What part of Maine?

MORGAN: Along the coast at Thomaston. They went there to work in the shipyards and that's where my mother had been born. I grew up there in Thomaston and went to high school there.

SKOLNIK: What did your father do?

MORGAN: At that time, he worked in the shipyards.

SKOLNIK: What kind of work in the shipyards?

MORGAN: He was a carpenter. He had been working in sawmills and doing carpentry work in New Hampshire.

SKOLNIK: Did you live in towns or in villages?

MORGAN: It was in a small village of about two thousand people.

SKOLNIK: You're a hick like I am. [laughter] Did you think Wilmington was an awfully big town?

MORGAN: It was pretty big.

SKOLNIK: Obviously then, when you went to Columbus, Ohio, you really got lost there.

MORGAN: Yes. That was a lot bigger.

SKOLNIK: Was your mother in any profession?

MORGAN: She was a school teacher. In fact, they had both been school teachers. My father was a school teacher at an earlier time.

SKOLNIK: Before he was a carpenter?

MORGAN: Yes.

SKOLNIK: He became a carpenter to earn more money?

MORGAN: I guess so. My grandfather, on my father's side, was a minister or pastor.

SKOLNIK: Of what denomination?

MORGAN: I guess the Universalists.

SKOLNIK: That sounds about right for that part of the country, especially, if you're from Massachusetts or the Boston area.

MORGAN: My father went one year to college to St. Lawrence University in New York, thinking that he might be a minister too, but then he changed his mind.

SKOLNIK: Back in those days, one year of college qualified you

to teach in the school system.

MORGAN: Oh yes. You could teach without even any college.

SKOLNIK: Did your mother go to any college?

MORGAN: Yes. She went to Gorham Normal School [later, Gorham State Teachers College, ed.].

SKOLNIK: That was a two year curriculum back then?

MORGAN: Yes.

SKOLNIK: Just like West Chester used to be until recently. So both of your parents were immersed in the educational field, even though your father went into the carpentry business. Because he was a carpenter did he put hammers and saws and screwdrivers in your hand when you were a child?

MORGAN: Yes. I got to use tools a lot.

SKOLNIK: So you're a good carpenter too?

MORGAN: I guess I am. I've done a lot of that. I've done a lot of woodworking.

SKOLNIK: Do you think that primed the pump for you to go into science? The fact that you were mechanical very early in life through your father.

MORGAN: That was one facet of it. I also, through my parents, got interested in nature subjects and was active as a collector of minerals and butterflies and things of that sort. I had a little museum which my father helped me build.

SKOLNIK: This is from the time you were a child?

MORGAN: At high school. Also, I was in the Boy Scouts.

SKOLNIK: Did you become an Eagle Scout?

MORGAN: No. My brother did but I didn't.

SKOLNIK: How far did you get?

MORGAN: I got up to Star.

SKOLNIK: That was the first step after first class.

MORGAN: I got twenty-nine merit badges but I wasn't much of an athlete.

SKOLNIK: And swimming stopped you?

MORGAN: Not swimming, but life saving.

SKOLNIK: Did you have to do life saving for the first class?

MORGAN: You had to do swimming but you didn't have to do life saving.

SKOLNIK: But the merit badges did require quite a bit of skill in life saving.

MORGAN: Yes. You also had to get another merit badge in physical fitness which required you to train another boy for three months. The requirements were quite a bit tougher then.

SKOLNIK: That I don't remember and I was an Eagle.

MORGAN: Well you might have gotten athletics.

SKOLNIK: Yes. I was an athlete in high school and college. Why were you non-athletic? Was it because you were a bookworm or because you were small and thin and lightweight?

MORGAN: I was a little on the heavy side. I was heavier than I am now.

SKOLNIK: You were heavier when you graduated high school than

you are now?

MORGAN: Yes. I was one hundred and sixty pounds.

SKOLNIK: So what are you now? One hundred and forty?

MORGAN: Something like that. One hundred and forty-seven.

SKOLNIK: You're about six feet tall?

MORGAN: Yes. I'm five foot ten inches.

SKOLNIK: Well that's a good weight for you. You should keep that weight.

MORGAN: Yes. The doctor recommends that.

SKOLNIK: Outside of the nature part, how else did your parents influence you towards science or towards intellectual life?

MORGAN: In many ways. My father was a real student. He knew Greek and Latin. He taught me Latin before I went into high school. We had an unabridged Webster's dictionary which had been given to him and we had a microscope. So I had lots of encouragement.

SKOLNIK: That's terrific for that period of time. I never heard of a microscope until I was in college.

MORGAN: We had those things and I built a little lab in the barn. I bought chemicals to analyze minerals with.

SKOLNIK: Was this before you took chemistry in high school?

MORGAN: Yes. I was making tests to identify them. Blow pipe analyses and things like that.

SKOLNIK: Did you know about the colors of the flames and things like chromium and so forth?

MORGAN: Yes. In fact, I took a course in mineralogy at the University of Maine and I probably knew more about mineralogy than the instructor at the time but I still learned a lot.

SKOLNIK: I guess your parents encouraged you to read a lot too.

MORGAN: Yes, they did.

SKOLNIK: What sort of books were they?

MORGAN: Both fiction and non-fiction. I read adventure stories, such as those by Zane Grey, Mark Twain, Sabatini, Cooper and Ernest Seton Thompson. How-to-do-it books on nature, electricity and mechanics-- Beard's The American Boys Handy Book and Harper's Outdoor Book for Boys. Another area that we got into was working puzzles. My father liked to work with puzzles, especially mathematical puzzles.

SKOLNIK: Crossword puzzles?

MORGAN: We did some crossword puzzles.

SKOLNIK: Cryptograms too?

MORGAN: We did all kinds of acrostics and simple mathematical problems that required algebra and geometry. This sort of thing made you search the dictionary for words so you got a lot of learning that way. My father got interested in radio and we built a crystal set. Later on we built a one tube set.

SKOLNIK: That would be in the 1920s?

MORGAN: Yes. Usually we would put up our own aerials.

SKOLNIK: You lived in Maine then. Would the crystal set bring in a station from Boston?

MORGAN: Yes. We could get Boston and Pittsburgh. We got Montreal too.

SKOLNIK: Of course this would be on clear days only.

MORGAN: Right.

SKOLNIK: Back in the 1920s you put up a really long antenna, didn't you? About one hundred feet long.

MORGAN: That's right. That's what we had. We went up in the woods and got a spruce pole and put an antenna up.

SKOLNIK: Of course you had to use earphones before the days of the loudspeaker. Did you use a pencil mark for your resistor for your crystal set?

MORGAN: I don't remember that we did.

SKOLNIK: You couldn't buy resistors back then in the 1920s unless you had some influence.

MORGAN: I don't remember what we did, whether we had something made out of wire or what.

SKOLNIK: I made mine out of a pencil mark. You had to experiment until you had the right resistance.

Do you remember any books you read when you were in junior high school and high school? Were they mostly in the science area?

MORGAN: A lot of them were in the science area. I read quite broadly. I wore the library out. We didn't have much money to buy books. One Christmas the only present I got was Gray's Manual of Botany, but that was way beyond my ability to understand.

SKOLNIK: Well it would be more memory than understanding. And isn't that the earmark of the medical profession--memorization rather than understanding?

MORGAN: We did have bird books and I borrowed books from the library on electricity and mineralogy.

SKOLNIK: Did you experiment with electrical things too?

MORGAN: Oh yes. We played with simple things.

SKOLNIK: You didn't rewire the house?

MORGAN: No. We had kerosene lamps. We had electrical circuits out in the barn that were made up of scrap. We used to go to the town dump and collect old wire and batteries from automobiles.

SKOLNIK: So you would generate your own electricity. Was it all DC or did you put up a generator?

MORGAN: We had magnetos from old automobiles. The telephone company dumped stuff at the dump too and we would pick that up. So we got little light bulbs and sockets and all kinds of things.

SKOLNIK: When you went to high school you took biology first and then chemistry and physics, I assume.

MORGAN: They didn't have any biology. They had one year in chemistry and one year in physics. I think I took chemistry first and then physics afterwards. This was a high school of about three or four hundred students.

SKOLNIK: So there were about seventy-five in your graduating class?

MORGAN: Well it didn't get that big. The freshmen class started at thirty-six when I was in it and ended up at nineteen. So the school must have only been half of what I said. Probably one hundred and fifty students.

SKOLNIK: What was your position when you graduated? Were you valedictorian?

MORGAN: Yes. I was also president of the class. And because they didn't have enough chemical supplies, a lot of the experiments were done by demonstration, and another fellow and I were lucky to get the privilege of preparing the experiments and doing the demonstrations. So I got extra experience that way.

SKOLNIK: So who influenced who the most? You to the teacher or the teacher to you? Was your teacher capable of teaching chemistry?

MORGAN: At least the simple stuff.

SKOLNIK: He was not well educated in chemistry?

MORGAN: I think he knew it. Actually he was the principal of the school. He was teaching math and science and athletics. So he was doing all of these things.

SKOLNIK: What part of athletics?

MORGAN: He was the coach for all sports--both the men and women's teams.

SKOLNIK: I guess the only thing the girls had was field hockey.

MORGAN: No. They had basketball. We didn't have field hockey and we didn't have swimming. There was no swimming pool. Mostly it was baseball and basketball and track.

SKOLNIK: Were you on the track team?

MORGAN: I didn't go out for this sort of thing. I was the manager of the baseball team for one year and that was about the extent of my athletics.

SKOLNIK: What year was that?

MORGAN: That was my senior year.

SKOLNIK: And I suspect you were drafted for that job.

MORGAN: Yes, pretty much.

SKOLNIK: Did you have a school paper?

MORGAN: They had a class publication but they didn't have a weekly or monthly paper.

SKOLNIK: Did you do anything for the class paper?

MORGAN: I wrote some horrible fiction. Others did the reporting.

SKOLNIK: Did you have any brothers or sisters?

MORGAN: I had one brother. He became a chemist too.

SKOLNIK: Was he older or younger than you?

MORGAN: Two years younger.

SKOLNIK: So evidently you influenced him towards chemistry.

MORGAN: I think so. He was an athlete and he became an Eagle scout. So he was different from me in some ways but we were very good friends and got along well.

SKOLNIK: He did not go to Du Pont though. What happened to him as a chemist?

MORGAN: He got his B.S. with me at the University of Maine. Then he later got an M.S. at Brooklyn Polytech. He had gone to work for American Cyanamid as a chemist in Stamford [CT]. He was there for fifteen years and later he became chief chemist for a plant owned by Inmont. They had a fabric coating plant in Winthrop, Maine, and he transferred up there as the chief chemist.

SKOLNIK: So he really ended up as a development chemist. Almost like an engineer.

MORGAN: Right. He did that and he traveled. He was with technical service and traveled around. He was sort of a salesman as well.

SKOLNIK: So he could do everything except research.

MORGAN: He did research at Cyanamid.

SKOLNIK: Has he published anything?

MORGAN: He had several publications and about a dozen patents. He died a few years ago in 1982. It was one of those unfortunate things, he got exposed to chemicals before the days of OSHA and EPA. He got liver damage from things like tetrahydrofuran, methyl ethyl ketone, vinyl chloride, and all of those horrible things that they allowed to get out in the plants.

SKOLNIK: I know that science was your favorite subject in high school. Were there other favorite subjects in high school?

MORGAN: I enjoyed school in general. I enjoyed English. I had three years of French which I enjoyed. I was never really an expert at it.

SKOLNIK: At reading French but not at speaking it. That's true for most of us chemists.

MORGAN: Yes. That's generally true of chemists unless they get to go abroad.

SKOLNIK: Going abroad never helped me any. I can still speak it but not the way that French like to hear it.

MORGAN: I've always had that trouble too.

SKOLNIK: My worst experience was in Quebec City. They speak a different French than the French do in France.

MORGAN: Sometimes the French don't want to talk to you either. They purposely make it difficult.

SKOLNIK: Did you study German in high school or in college?

MORGAN: I did that in college. I had two years of regular German and half a year of technical German. Again, I can mostly read it although I joined a German club that put on little plays and things like that. I'm not especially good at it.

SKOLNIK: So then there was nothing in school that you disliked except athletics.

MORGAN: I guess so. I don't know that I disliked athletics other than that I wasn't interested in it. In the scouts I was doing lots of hiking and bicycle riding. We took long trips, camping.

SKOLNIK: So you passed the camping merit badge.

MORGAN: Oh yes. Fifty nights of camping. I did the hiking merit badge which require three months of walking.

SKOLNIK: Why did you choose the University of Maine for your undergraduate work? Was that influenced by your teachers in high school?

MORGAN: That's a little bit of a roundabout story. As I said, we didn't have much money. There was a scholarship available in the town to go to Harvard which was for about $900. They were supposed to pay your tuition plus a contribution towards other expenses.

SKOLNIK: It was tuition, room, and board?

MORGAN: Oh yes. It was several hundred dollars for tuition.

SKOLNIK: But then clothes and travel expenses are on you.

MORGAN: I had relatives in Massachusetts which would help. I applied for this and got approval with the exception that I had to share it with one other student who was already at Harvard. That meant cutting it in half and I couldn't manage that.

SKOLNIK: Did your scholarship at Maine include tuition or tuition, room, and board?

MORGAN: I didn't have any scholarship at Maine.

SKOLNIK: It was a state university under a land grant?

MORGAN: Yes. Tuition was quite low.

SKOLNIK: It still must have cost you between three and four hundred dollars a year.

MORGAN: I eventually went there and I chose chemistry. It cost me about five hundred dollars a year to go to Maine over the four years. Actually it ended up being a little less than that because of a number of things. The first year I stayed in the dormitory. The second year, I boarded myself with another student in a small cabin where we did our own cooking and washing. After high school I stayed out one year doing work to accumulate some money.

SKOLNIK: What was the salary that you earned that year?

MORGAN: I was getting ten or twelve dollars a week. So I managed to save up enough money to get through those first two years. Then my brother and I had agreed that we would each work two years and support the other. I would work two years and support him which I did. Then by the end of my second year, my mother died in that period. She died in about 1935. She had several hundred dollars in stocks that were set aside and we inherited that.

SKOLNIK: Do you remember what the stock was?

MORGAN: AT&T

SKOLNIK: A good one. [laughter] You should have held on to it.

MORGAN: I know. We probably would have done better to invest it.

SKOLNIK: In those days it must have been worth about fifteen dollars a share.

MORGAN: I lost money in the bank. I had thirty-three dollars left in my bank account when the banks closed down, which I lost. I eventually got back a few dollars on it.

SKOLNIK: I remember very vividly how many people got hurt.

MORGAN: During those two years I was working at the A&P seventy hours a week for ten dollars.

SKOLNIK: Did they have NYA [National Youth Administration] at

Maine when you were there?

MORGAN: Yes, they did.

SKOLNIK: Did you work under NYA?

MORGAN: No, I had a job working in the chemical store room. I don't remember how much that paid but that paid my lab fees and a little bit of extra money too. Plus a lot of experience because I got to make all of the solutions. That also included cleaning solutions and nitric acid. So my brother and I went back to school. We bought a piece of land for seventy-five dollars and built our own cottage with our father's help and lived in that for two more years and graduated together.

SKOLNIK: What about the chemistry professors at the University of Maine? They must have had some influence on you.

MORGAN: They did. Well the organic chemistry professor wasn't that great. He was good. He was a very enthusiastic organic chemist named [William L.] Gilliland. I did all of the things that were done at that time. I did lots of analytical work and lots of wet chemistry that you don't do any more. We had no instruments other than analytical balances.

SKOLNIK: That's all we had back then -- wet chemistry.

MORGAN: Fertilizers and ores and all kinds of minerals.

SKOLNIK: Limestone was the toughest thing especially doing the silica and the Fe_2O_3. That taught us patience back in those days.

MORGAN: When we were both in our last year, people came around interviewing for industrial jobs. My brother took this job with American Cyanamid. I interviewed too but I told the people that I wanted to do research. They told me that I didn't have much of a chance to do research with a B.S. and I probably ought to get an advanced degree. So I talked with the professors and they agreed to support me if I made applications to schools and I did that.

SKOLNIK: Was there one professor in particular who was of most benefit to you?

MORGAN: There was the head of the department, [Charles A.] Brautlecht. He was an inorganic-physical chemist, but he was very enthusiastic about the idea of doing advanced studying. Then Gilliland, who was the organic chemist, was also interested. They wrote letters of recommendation and I got several chances and picked Ohio State.

SKOLNIK: Did you write to the universities or did the professors recommend the universities?

MORGAN: I wrote myself. I went to the library and looked up the addresses.

SKOLNIK: Why did you decide on Ohio State? Did you apply to Harvard?

MORGAN: I don't think I tried Harvard. I tried about fifteen schools. I got positive answers from Iowa State, Penn State, and Ohio State. I honestly don't know why I chose Ohio State.

SKOLNIK: Particularly since [Frank] Whitmore was at Penn State.

MORGAN: Whether it had to do with something I knew about the professors or something that somebody on the staff at Maine had said to me, I don't know. Brautlecht asked me that same question. [William L.] Evans and [Wallace R.] Brode and people like that were at Ohio State. [Henry] Gilman was at Iowa.

SKOLNIK: There was no question that you were going to go to graduate school for organic and not for physical chemistry.

MORGAN: I had decided by then that I wanted to do organic chemistry. I think the reason was because there was a lot of interest in vitamins at that time. It was sort of a glamorous time.

SKOLNIK: Then you had a leaning towards the natural products side.

MORGAN: Yes.

SKOLNIK: Did you have any leanings towards the medicinal or pharmaceutical side?

MORGAN: I was interested in medicinal things. I remember I got a book from Brautlecht on chemistry and medicine. It wasn't a very good book but it was a book that I read and it had some influence.

SKOLNIK: There still is not a good book on that subject.

MORGAN: But I had read other things like Paul de Kruif's books on Microbe Hunters, Iron Man, and all that (1). Some of those things had influence. There wasn't much organic chemistry at Maine and so I really didn't learn a lot there.

SKOLNIK: They were pretty weak on the mechanistic side of organic chemistry.

MORGAN: Gilliland was interested in Grignard reagents and zinc alkyls.

SKOLNIK: I'm really surprised that you didn't go to Penn State because Whitmore was the great one on Grignard reagents. He brought out the mechanism beautifully.

MORGAN: Gilliland was also interested in sodium hydrides. In fact I tried to make that for him but didn't succeed very well.

SKOLNIK: It's sort of dangerous too.

MORGAN: Oh, it's very dangerous. I scared everybody in the laboratory because we did it out on the open bench.

SKOLNIK: Did you have hoods back then?

MORGAN: We had hoods, but they were not much good.

SKOLNIK: Particularly in general chemistry. We used hydrogen sulfide. I'm surprised that many of us lived through that course because the amount of hydrogen sulfide in the atmosphere was way beyond the hazardous limit.

MORGAN: People would pass out from it every once in awhile.

SKOLNIK: Was there any course in college that you didn't like?

MORGAN: Yes. I took a course in business law. I didn't do very well and I suppose maybe that's why I didn't like it. Or maybe I just didn't like it and therefore I didn't do very well. It required quite a bit of memory and I didn't seem to have much. It went beyond what I was interested in at the time. I did fairly well in mathematics up through calculus. I tried a course in differential equations and didn't really finish it for credit. That was about as far as I got.

SKOLNIK: Did you use the Cohen book for differential equations (2)?

MORGAN: I don't remember the author. It was a little thin book.

SKOLNIK: Yes. He was a mathematics professor at Johns Hopkins. That's the one I used at Penn State. I thought it was a perfect little book. Ms. Cohen was my instructor and her brother wrote the book. I forgot his first name. Maine was a land grant college so that meant that you took ROTC.

MORGAN: I took ROTC for two years.

SKOLNIK: How did you feel about that?

MORGAN: It was something to do.

SKOLNIK: Did you enjoy it or did you find it distasteful?

MORGAN: I kind of enjoyed it. It had a discipline and I didn't mind that.

SKOLNIK: How did you do in markmanship?

MORGAN: Very good because I had already gotten a lot from certain merit badges in the scouts. I had a twenty-two caliber rifle of my own. Although the rifles that they had were heavier, they had twenty-two barrels on them. I had to take the regular PT physical education program which I did for awhile. I also did fencing which was an interesting thing to do.

SKOLNIK: So courses like physics and physical chemistry really did not bite you as organic chemistry did?

MORGAN: Physical chemistry was okay. I did all right on that. But I guess it didn't send me like organic chemistry.

SKOLNIK: I'm surprised that you didn't go more for analytical since you did so much work in the storeroom.

MORGAN: Oh yes. I liked analytical chemistry, despite long lab periods. You had to work Saturdays and get in enough time to get your analyses done. But I enjoyed that.

SKOLNIK: It must be completely different today.

MORGAN: Yes. I can imagine what it's like today. There are all the instruments that you could ever imagine.

SKOLNIK: Don't you think analytical chemistry really taught us chemistry that you do not get with instruments?

MORGAN: I feel it was a discipline that made you do things carefully and thoughtfully. You knew what the chemicals were and what they looked like and what they were made of.

SKOLNIK: And what they smelled like.

MORGAN: Very important. Although I've not acquainted enough with college courses these days, I'm a little concerned that people are so far from chemistry that they won't know what chemicals are like. That turns up in some of those stories that you've seen. I think that's why the program that you have in the schools is good because students get a chance to see chemicals and work with them.

SKOLNIK: Every chemical that I bring into the classroom, I take out of the kitchen.

MORGAN: That's true. You have to be safe.

SKOLNIK: Well not only that, it's chemicals they know like baking soda, vinegar, and lemon juice. Then I can give them litmus paper and they redo the whole experiments again with their

parents. I think they're teaching their parents something too. What's an acid and what's a base.

Did you have an assistantship the first year that you were at Ohio State?

MORGAN: Yes. That was the basis for going to any of these places.

SKOLNIK: How much did they pay you?

MORGAN: Four hundred and fifty dollars a year.

SKOLNIK: You had to have a scholarship to go.

MORGAN: Yes. The next grade up in the assistantship program was $750. I didn't get that.

SKOLNIK: Was your assistantship in analytical or inorganic or general?

MORGAN: It was in general chemistry. We taught the freshmen students. In the beginning we had lab classes. Later on we had quiz classes too. Ohio State was a big school with lots of pre-med students, nurses, and all the general students taking the first year of chemistry.

SKOLNIK: Even the metallurgists took one year of chemistry.

MORGAN: All of the engineers were required to take basic chemistry.

SKOLNIK: So your lab courses had one or two hundred people in them and there were three or four or five people like you monitoring the experiments.

MORGAN: Yes.

SKOLNIK: When did you have to choose you professor at Ohio State?

MORGAN: The second year. During the first year you went around

and interviewed with different professors to see what kind of programs they had and whether they would take on students or not. So I did that. I talked with all of the organic professors. They were William Lloyd Evans in carbohydrates, Wallace R. Brode who was in spectroscopy, Cecil Boord was in hydrocarbons, and [Melville L.] Wolfrom was in carbohydrates and plant pigments. Brode was working on dyes and dye structures.

SKOLNIK: Was he more like a physical chemist?

MORGAN: Yes. He was a physical chemist. He was actually working on a UV spectrometer before the Cary came out. He had a student working this out on a big table. I did experiments in that area where you did one wavelength at a time. But they were working on a machine that would do a whole scan. [Albert L.] Henne was there, working on fluorocarbons. Melvin Neuman also; he worked in organic chemistry.

[END OF TAPE, SIDE 1]

MORGAN: Evans wanted me to work with him very much but I didn't want to do carbohydrates.

SKOLNIK: But you did eventually. [laughter] That's fate for you.

MORGAN: I worked two years on plant pigments. Then I couldn't find a job. That was in 1940. I got my Ph.D. in the spring of 1940. Then I couldn't find a job. I went all over.

SKOLNIK: What did you do? Did you write a lot of letters?

MORGAN: Yes, including Du Pont.

SKOLNIK: 1940 wasn't a good year as I recall.

MORGAN: No, it didn't seem to be.

SKOLNIK: Even though the war broke out in Europe.

MORGAN: Wolfrom had this cellulose fellowship which was sponsored by Du Pont. The person who was on it had been on it for one year and there was one more year to go. I took that over

and had it for a year.

SKOLNIK: That was your postdoc at Ohio State. What did they pay you for that?

MORGAN: I got two thousand dollars.

SKOLNIK: That's not too bad when you consider the starting salary for Ph.D.s back then was three thousand.

MORGAN: I was married by then. I had been married for a year.

SKOLNIK: Where did you meet your wife? At Ohio State?

MORGAN: No. She was from Thomaston, Maine.

SKOLNIK: So when you went back in the summertime that's when you were courting her.

MORGAN: That's right.

SKOLNIK: Was she in college then?

MORGAN: She was working in Thomaston as a governess with a family and getting room and board and some pay. We got married during my last year. We rented an apartment in Ohio.

SKOLNIK: This was in 1940?

MORGAN: No. I was married in 1939. [Mrs. Elsie Bridges Morgan died 3/18/89: ed.]

SKOLNIK: So she moved to Columbus when you were a postdoc. How did she like Columbus when she first moved there?

MORGAN: It wasn't too bad. It was a dirty city at that time because everybody burned soft coal. But it's a fairly mild climate.

SKOLNIK: It's not as mild as Delaware, but it was mild as

compared to Maine.

MORGAN: Right. Columbus was a big city but, like all cities, it was not as big as it is today. She used to walk up to the lab every night and stay up there until I got through at about eleven o'clock.

SKOLNIK: What time in the morning did you start at?

MORGAN: I was up there certainly by eight o'clock.

SKOLNIK: It was a long day then. You were still a graduate student when you were married in 1939 and you were in the lab from eight until eleven. Were you still there from eight to eleven as a postdoc?

MORGAN: Yes.

SKOLNIK: You couldn't do this in Buffalo when you went to Buffalo for Du Pont.

MORGAN: That was a vacation compared to this.

SKOLNIK: When you went to Du Pont could you work more than eight hours a day if you wanted to?

MORGAN: You weren't supposed to because of safety reasons. I did go in on some Saturdays when we had special projects going.

SKOLNIK: Didn't you have to work Saturdays when you first started with Du Pont.

MORGAN: In the beginning we did. When I first went there they were working Saturday mornings.

SKOLNIK: Tell me about your reactions to your colleagues at Ohio State--your fellow graduate students and also your professors. What were your reactions to them?

MORGAN: I got along very well with nearly all of the professors. Some of the people in the freshmen area I didn't care for too much.

SKOLNIK: You're talking about the people you had to be an assistant to.

MORGAN: [Laurence L.] Quill and I didn't get along too well.

SKOLNIK: He was the professor for general chemistry.

MORGAN: Yes. He was a military type who had a high degree of discipline.

SKOLNIK: When he lectured, did you have to sit in the lecture too? Or did just one of the assistants sit in there?

MORGAN: We did some. Evans did some lecturing.

SKOLNIK: So they did separate the lecturing from the laboratory.

MORGAN: We had to sit in there. There were a large number of assistants. I suppose there must have been fifty assistants. They had an assistant in charge and he had an assistant. It was a very highly organized teaching staff.

SKOLNIK: Was this the way that Quill organized it or did all of the professors organize it this way?

MORGAN: It was organized under Quill.

SKOLNIK: Who was the head of the department at Ohio State then?

MORGAN: Evans was.

SKOLNIK: For the several years that you were in graduate school?

MORGAN: Yes.

SKOLNIK: Did he influence you at all?

MORGAN: Not a lot. I liked him and got along well with him, but

we didn't have a lot of contact.

SKOLNIK: Did he talk chemistry with you or was it always business?

MORGAN: It was mostly business. I had [Herrick L.] Johnston in thermodynamics, [Willis C.] Fernelius in inorganic, who was at Kent State as an adjunct professor until recently.

SKOLNIK: Yes. He and I are on the Nomenclature Committee together. He's a consultant and so am I.

MORGAN: He was a real dynamic type of person and very well organized in inorganic chemistry. I learned a lot from him. I had [Cecil E.] Boord in organic. I had analytical organic under Boord, but it was taught by an assistant whose name I don't remember.

SKOLNIK: What about the other graduate students? Any of them close friends with you?

MORGAN: I roomed with a fellow named [John H.] Blomquist who later came to Du Pont. He was a physical chemist. Robert L. Griffith who went to Eastman Kodak was a physical chemist. I worked with Stan [Arthur S.] Gregory in the research labs. He worked for Du Pont and then for Weyerhaeuser. There was a fellow named Emil Wiest who went to Du Pont Organic Chemicals Department.

SKOLNIK: Quite a few of you went to Du Pont.

MORGAN: Du Pont hired a lot of people but they went to different departments.

SKOLNIK: It seems to me that one or two of them went to Hercules from Ohio State.

MORGAN: I wouldn't be surprised. I knew Buckingham who is in Wilmington now. He worked down in Baltimore for Du Pont. I guess that's in pigments. Frank B. Moody, who used to live in this neighborhood, was at Ohio State.

SKOLNIK: Were most of your friends the first year graduate students at Ohio State? Or was it more democratic and you were

friends with the second and third and fourth year graduate students and postdocs?

MORGAN: I didn't get to know many people who were not in the graduate school and who were in chemistry at some time or other. I knew some people because I roomed with them.

SKOLNIK: And you shared laboratories with some, I assume?

MORGAN: Yes. I had a laboratory with John E. Mahan. I think he went with Phillips Petroleum. [Francis] Lee Benton was another lab partner and he went into teaching at a small school in Illinois.

SKOLNIK: Did you have any desire to become a professor as you were approaching the end of your Ph.D.?

MORGAN: I didn't consider that. It was a bad year to get a job anywhere.

SKOLNIK: Weren't they trying to recruit for the armed forces back in 1941?

MORGAN: There was some of that. We weren't in the war until that fall.

SKOLNIK: Were you close to being drafted at any time?

MORGAN: Yes. I got deferred. We had a number of students, in fact, we had some student assistants in the research lab, and some of them were suspect. I remember that very vaguely. I know that they were investigated.

SKOLNIK: These were seniors in the college?

MORGAN: Yes. They were being paid by the government somehow as assistants. But they were being investigated as to their political background. We had trouble with that side. We had trouble getting them deferred. Of course, I was in my late twenties and as soon as I went to Du Pont, they began to get deferment. I went to Maine on a two week vacation in the town and my draft board was in. Somebody saw me and I immediately got changed to 1A and the company had to fight to get me deferred again.

SKOLNIK: That happened to quite a few of us who came from small towns. How did you decide on your thesis? Did Mel Wolfrom design your thesis or did you decide that it's going to be on osage-orange?

MORGAN: He convinced me that this is what I wanted to do. He had this program on osage-orange [maclura pomifera] pigments. It was already going and he had two other students on it already. One of them was Bill [William W.] Hess who came to Du Pont too. He worked in the personnel department. I had agreed that I would work on the osage-orange pigments. He assigned what part of that program we would do. This was back in the times when you hit everything with a sledgehammer.

SKOLNIK: You did all of your own analytical work too?

MORGAN: We did a lot of it. We didn't do carbon and hydrogen [microanalysis].

SKOLNIK: Did someone else do that for you?

MORGAN: Yes. We sent it to Germany. Wolfrom didn't trust American analysts.

SKOLNIK: I was in graduate school at the same time you were and we had to do our own carbon, hydrogen and nitrogen. Did you do your own nitrogen?

MORGAN: We did our own nitrogen and acetyls and carboxyls.

SKOLNIK: Did you do it by macroanalysis or semimicro?

MORGAN: Semimicro.

SKOLNIK: But not your carbon-hydrogens?

MORGAN: We didn't do carbon-hydrogens. Later on there was a chemist funded at Ohio State who did them. He became reliable in Wolfrom's eyes.

SKOLNIK: Who paid for the carbon-hydrogen analysis?

MORGAN: The university. They had a research fund that Wolfrom had access to. He had become convinced that this was the way to do it. When he didn't send them there, he sent them to some other American laboratory that did carbon-hydrogens.

SKOLNIK: Your Ph.D. thesis was on the osage-orange pigment. When did you get to the isoflavones? Was that as your postdoc?

MORGAN: That's what these pigments turned out to be.

SKOLNIK: I know, but first you had to determine the composition. Wasn't that your thesis--the determination of the composition of those osage-orange pigments which are isoflavones (3)?

MORGAN: Yes.

SKOLNIK: Then you did research on isoflavone as an entity by itself?

MORGAN: We did do some work on that but only as a practice to understand the difference from osage-orange pigments themselves.

SKOLNIK: So you went through reactions of the isoflavones.

MORGAN: We looked up a lot of chemistry on natural pigments and how to characterize them.

SKOLNIK: You had to know a lot of German for that project.

MORGAN: Yes. That's right.

SKOLNIK: And of course you had your nose in Beilstein every week too.

MORGAN: We were reading Willstätter and all the other guidelines in this area. So we got to appreciate that they did work on very small quantities. This whole program had to be worked out on very small quantities.

SKOLNIK: How about the gluconates? Was that your postdoc (4)?

MORGAN: Yes, that was my postdoc.

SKOLNIK: When did you hit cellulose?

MORGAN: Cellulose was in the postdoc too (5).

SKOLNIK: These were the water soluble celluloses.

MORGAN: Yes. Wolfrom had a program on heparin and he wanted to work on cellulose sulfate and other cellulose derivatives.

SKOLNIK: How did he go from heparin to the water soluble cellulose? There's no relationship there.

MORGAN: No, there isn't, but he had an idea that the cellulose sulfate might have a related anti-coagulant effect on blood. I don't know why we were working on the gluconates. He had some idea that it was going to make a super-explosive by nitrating it.

SKOLNIK: What part of the nitrate? Was it the gluconate itself that you wanted to nitrate?

MORGAN: We made a gluconated cellulose. He wanted to nitrate that.

SKOLNIK: He nitrated that to cellulose. The hydroxyl groups in the cellulose. Did the nitric acid/sulfuric acid mixture eat up the gluconate? Did it destroy the gluconate?

MORGAN: Yes. I guess it did.

SKOLNIK: If you're going to nitrate cellulose you're going to have to have a lot of nitro groups before it's an explosive grade.

MORGAN: That's true. We didn't get very far with that.

SKOLNIK: But it got you into the literature. I notice that you have a publication that surveys the literature on this (5). That must have been one hell of a lot of reading.

MORGAN: It was. [laughter] There were some three hundred references. Some of them I was translating.

SKOLNIK: Were you translating for Wolfrom or yourself?

MORGAN: I had to write an abstract of each article.

SKOLNIK: Since you were at Ohio State did you ever have any relationship with Chemical Abstracts?

MORGAN: Yes. I got to be an abstracter for them.

SKOLNIK: In what year? You knew Evan J. Crane then very well.

MORGAN: Yes. I was abstracting while I was at Ohio State and after I left, for a number of years, back when they had individual abstracters. They had a long list of people who were doing the abstracting.

SKOLNIK: I was just wondering who was there first--you or me?

MORGAN: This was 1940.

SKOLNIK: So it was before you got your Ph.D. I think Crane recruited me in 1945.

MORGAN: It was a little before then. I don't remember when I stopped.

SKOLNIK: Did you ever have a specific field when he recruited you or was it just organic chemistry?

MORGAN: I was doing mostly organic chemistry and a fair amount of cellulose.

SKOLNIK: That would have been a separate section from the organic.

MORGAN: I think I was picking up all of the chemistry they

didn't have anybody to do. I was doing French and German which is a tough way to make any money. You didn't make any money anyway.

SKOLNIK: I asked them to give me only French and German. They started sending me a bunch of English patents and I revolted against that. I said, "I can read English very well. It's the French and German that I want to be expert at."

MORGAN: That was kind of fun but time consuming.

SKOLNIK: What year did you go to Du Pont and work for them?

MORGAN: [W. Hale] Charch was the laboratory director. He came out recruiting in 1941.

SKOLNIK: Were you in the Fibers Department?

MORGAN: Yes. Then it was called the Rayon Department.

SKOLNIK: What was your first assignment in Buffalo?

MORGAN: I worked on cellulose. The first thing they asked for was two pounds of cellulose sulfate. Actually, I was working on cellulose acetate and hydroxylethyl cellulose.

SKOLNIK: This was in a research laboratory.

MORGAN: Yes. This was the beginning of the Pioneering Research Laboratories. It eventually became the Pioneering Research Lab at the Experimental Station.

SKOLNIK: Did you know Will [Wilfred W.] Smith?

MORGAN: There was a Smith in the patent division.

SKOLNIK: Eventually; but first he was in the laboratory.

MORGAN: I didn't know him in the lab.

SKOLNIK: He got his Ph.D. from Yale, I think in 1929. He's still alive but just barely. How about Carleton Conrad? Did you know him?

MORGAN: I knew him later but I didn't know him then. There were people like [Joseph B.] Quig. [Emmette F.] Izard was there. I went to work for him. He was the fellow who developed polyethylene terephthalate.

SKOLNIK: You had some publications and patents (6).

MORGAN: Yes. He worked on cellulose and vinyl polymers. Then he was on polyethylene terephthalate. He did the original work for Du Pont on polyethylene terephthalate before we learned about the ICI work.

SKOLNIK: What do you think about the fact that the English beat the Du Ponters on the terephthalate? The terephthalate that was discovered and patented in England by this small company [Calico Printers Association] was bought up eventually by ICI.

MORGAN: Calico Printers were in there and they got the early patent (7). Du Pont got licenses under the patent.

SKOLNIK: And became the number one producer in the United States.

MORGAN: Yes. Du Pont actually produced the fiber here in this country before ICI got it going.

SKOLNIK: That's because of the research they did on 66 nylon. They had a good basis for developing another fiber. I don't think ICI had really done anything on that. They are very strong now on fiber production at ICI. Who was your first boss in Buffalo at Du Pont?

MORGAN: That was Emmette Izard.

SKOLNIK: He was a good man to work for. He was a brilliant chemist.

MORGAN: He was great. He was a good organic chemist and he had worked at the Experimental Station before he went up to Buffalo to work on organic chemistry, plasticizers, and things like that.

SKOLNIK: How did Du Pont feel about publications back in the early 1940s?

MORGAN: There wasn't much going on.

SKOLNIK: Didn't they discourage publications?

MORGAN: On the whole, I think they did.

SKOLNIK: You have no publications at all from Du Pont during that period. You have to go to the 1950s.

MORGAN: That's not quite true. I had one in 1946 (6) and one in 1948 (8) as well as one with Izard a year later (8a).

SKOLNIK: The chemical companies didn't mind publishing analytical procedures.

MORGAN: I came down to Wilmington in 1950. This work, and for some of the following publications, was done in Buffalo.

SKOLNIK: Was there much problem in clearing these papers in Du Pont for publication?

MORGAN: No, there wasn't. They didn't undergo the kind of review that they do today. They went through the laboratory people and then they went to W. W. Smith in the Patent Division. They may have been shown to some other people but it wasn't a very formal review other than going to the patent division. Charch was interested in publications but I think the inspiration for this had to come primarily from the chemist and it's almost always been that way.

SKOLNIK: Then you really had a desire to publish your results?

MORGAN: Yes. Wolfrom was a strong proponent of publications.

SKOLNIK: How do you account for the fact that so few of us do publish? Is it laziness to write?

MORGAN: There are two things. One is laziness. It takes a certain amount of get-up-and-go to do that, and an interest. But the industrial chemist is discouraged from it in a number of ways. One is that often nobody says that we want you to publish. Sometimes they do but it doesn't get him very much either. He sees it as not getting him any more pay. It doesn't get him any credit within the company.

SKOLNIK: But it puts him down in the history of chemistry.

MORGAN: Yes, it does. So he has to want that.

SKOLNIK: But don't you think most of the good chemists have that desire to go down in history as being a good chemist?

MORGAN: I don't see that. I don't mean that I don't understand it, but I don't see it in the chemists.

SKOLNIK: But you have it.

MORGAN: Yes, and I have some colleagues who have it too. I guess I'm talking primarily from my own experience. Most chemists don't see that they're going to gain advancement or more pay from publication. I agree with you that they're going to get to go to meetings, if they want to. It's a crutch for doing that. But the other side of this is that they're discouraged from publication by the review process. They go through all the work of writing and then people knock it down and say it isn't good enough or refuse to release it.

SKOLNIK: Or that it reveals too much information to your competitors.

MORGAN: Yes. So they get called on that. The process of review within the company is so extensive that it's very discouraging and they give up after a few tries. It's only a selected few that push and keep on trying. Out of the hundred chemists that were in the lab where I worked, probably only half a dozen or so have publications.

SKOLNIK: That's pretty high for the total chemists who publish. When did you become involved in polymer chemistry. I'm now talking about the synthetic polymers.

MORGAN: When I got promoted to research associate back in 1945

or 1946, that publication was one of the first things that came out of it.

SKOLNIK: That's the "Dicarboxylic Acids and Esters containing the Phosphine Oxide group." (9)

MORGAN: As a research associate I started the program on polymers with phosphorus links.

SKOLNIK: What really came out of that?

MORGAN: Nothing. We had the idea that changing linkages might change the properties of the polymers but, if you only put a small amount in, it gets buried and then they're no different from carbon. We had programs on putting in sulfur, silicon, phosphorus, and so on.

SKOLNIK: After you made the polymer and reacted these things together, you could have crosslinks.

MORGAN: That was another possibility.

SKOLNIK: But back in those days you didn't go that far?

MORGAN: Not with that one. The thing that I missed in there was the polyphosphazenes. I worked on them for awhile but never got very far. Now we have [Harry R.] Allcock of Penn State with his great program in that area. It was there. It was one of those things that I could have discovered if I had done the right thing.

SKOLNIK: I guess you have a lot of instances like that in your career. I can say the same thing. Then, when did you get into the interfacial condensation polymerization?

MORGAN: That didn't come until we were down here in Wilmington in 1950. I did that nylon trick experiment in 1951.

SKOLNIK: But you didn't publish it until the late 1950s.

MORGAN: We talked at the Gordon conference in 1957.

SKOLNIK: I think that was the first announcement of it.

MORGAN: Right. Then we talked in Chicago at the ACS and publications came out in 1959 (10).

SKOLNIK: For which you got the [American Chemical Society] Delaware section best paper award. You and Stephanie Kwolek. Stephanie was your laboratory partner almost from the very beginning.

MORGAN: Yes. She had worked for other chemists.

SKOLNIK: Was she in Buffalo at the same time you were there?

MORGAN: Yes, but she didn't work for me there.

SKOLNIK: Did she transfer at the same time that you were transferred?

MORGAN: Yes, and about that time she went to work for me. She worked for me for twenty-five years.

SKOLNIK: When she first worked for you, what sort of chemist was she?

MORGAN: She was a research chemist and she eventually became a research associate.

SKOLNIK: And your final title was Senior Research Fellow.

MORGAN: Yes.

SKOLNIK: What sort of impression did she make on you when she was first assigned to you? Did you know she was a hot shot chemist or were you the professor that made her the hot shot chemist?

MORGAN: I suppose some of the things rubbed off but one never knows. She was a very careful, meticulous experimenter. She had worked for Izard in Buffalo. That was when I was a research associate. I was away from Izard by then and on my own. She was working for him and also for Emerson L. Wittbecker for awhile.

She's a smart chemist.

SKOLNIK: Did she do a lot of reading and studying during this period?

MORGAN: She reads the literature carefully and researches it carefully.

SKOLNIK: Did you use her for helping you in your own literature researching or did you do you own?

MORGAN: We worked in the same laboratory most of the time, but I did my own literature searching.

SKOLNIK: But she always reported to you. You were always her boss.

MORGAN: Yes. I was her boss working in the labs and working at the other side of the room. I made a special effort not to be leaning over her shoulder. That's hard on a person. We got along very well. She had separate assignments although we frequently worked on programs that were very close, where she had one part of it and I had the other part. But at other times she had programs that were quite different from mine.

SKOLNIK: Did she ever get a patent with only her name on it or were all of her patents with your name?

MORGAN: Yes, some on her own (11).

SKOLNIK: You were running a race on who has the most patents. [laughter]

MORGAN: She has quite a few, more than most of the chemists in the laboratory. They've got a display in the hall of the laboratory of people's pictures now (they didn't have it then) and under them were the patents that they had.

SKOLNIK: How about publications? Did they have that for publications too?

MORGAN: No. They have another display in another area that has some of the awards that we've won. I'm in there and she is and

some other people. They're not paying as much attention to publications as they are to patents. The special thing about patents was that we had to keep notebooks and records.

SKOLNIK: Well, you had to do that for publications too.

MORGAN: But what I'm leading up to is that in better publications, authorship can be rather different than inventorship.

SKOLNIK: That's right because I know no one looks at your records for publication as they would for patents.

MORGAN: With patents it has to be the records and you have to be the first and you have to have a concept and you have to reduce it to practice.

SKOLNIK: Have you ever lost a patent because you did not record the idea at the right time?

MORGAN: I've not lost a patent by not recording them. But by not taking the thought, working on it, doing the experiment and writing a letter or a note to somebody else, even though I had somebody else witness the notebook. That's not enough always.

SKOLNIK: Reduction of practice. So that's where you lost out on some patents.

[END OF TAPE, SIDE 2]

SKOLNIK: Tell me about some of your philosophical views on life and science in general.

MORGAN: I think my career in science has been a very rewarding one in terms of having work that you enjoy to do and get paid reasonably well. I think that's one of the things that most people who have been in science and have had a good career would say. There are frustrations with being an industrial chemist in terms of freedom to do things.

SKOLNIK: You mean there were things you wished you could have researched that Du Pont would not let you research.

MORGAN: An industrial chemist usually has to be doing something for the company. He has to do his assignment as best he can. In the kind of position that I had, you could do that and then you could do... In fact I was encouraged to do additional things that might lead to new programs.

SKOLNIK: That certainly happened to you with the interfacial condensation polymerization. You discovered that. Whatever lead you to that concept? What were the two immiscible liquids you liked best of all?

MORGAN: We weren't as safety conscious as we are today.

SKOLNIK: What was your diamine in?

MORGAN: The diamine was in water as the free base and the diacid chloride was in carbon tetrachloride.

SKOLNIK: Did you rather work with the sodium hydroxide or did you rather work with excess diamine to absorb the released hydrochloric acid?

MORGAN: We were using sodium hydroxide. We had already been stirring these systems as an emulsion. We were even adding detergent and thinking that it was necessary to get lots of surface.

SKOLNIK: Why is it better to use two immiscible solvents than to dump your diamine and diacid in the carbon tetrachloride or some other solvent?

MORGAN: That doesn't work. You get a reaction but the product precipitates so rapidly that there is no high polymer. It doesn't go to high polymer. This isn't a universal truth but it's true for that particular system.

SKOLNIK: Did you ever try it in a dry state without any solvent?

MORGAN: Yes.

SKOLNIK: What was wrong with that?

MORGAN: There are some systems, for example terephthaloyl

chloride and a diamine, such as piperazine, that you can grind together and they'll polymerize fairly well.

SKOLNIK: This is with some heating.

MORGAN: The force of the grinding gives you enough heat to start the reaction and the evolved heat keeps it going.

SKOLNIK: Is this with or without a catalyst?

MORGAN: It's without a catalyst. It's a very vigorous reaction. In fact that's one of the reasons for using the solvents is to moderate the reaction and absorb some of the heat.

SKOLNIK: When you used the acid chlorides how did you get rid of the hydrochloric acid?

MORGAN: You may evolve some hydrogen chloride which will also combine with the amine and make an amine salt.

SKOLNIK: So you add excess diamine?

MORGAN: Yes. And the piperazine type of system will work with two moles of diamine to one mole of acid chloride. Hexamethylene diamine won't do that. The piperazines are a little peculiar and maybe are unique.

SKOLNIK: You must have tried a lot of different combinations. Was this by your own ideas or by assignment from your superiors?

MORGAN: The program of making polymers by combining acid chlorides and diamines was already started by Wittbecker. He was making polyurethanes. The rest of us organic chemists in the group saw right away--and he did too--that this could be applied to a lot of different reaction processes. So we divided up the field--amides and esters and urethanes and sulfonamides and so on. I took on the mechanistic aspect. We had a group working on different aspects. That's why I did this experiment.

SKOLNIK: What did you react your isocyanates with?

MORGAN: With diamines. Wittbecker's work was with bis chloroformates and not isocyanates, although we did do some work

with isocyanates--hexamethylene diamine and hexamethylene isocyanates.

SKOLNIK: Did you do that in solution?

MORGAN: We were doing it in two phases and later on we did it in solution because you don't have to have a solvent or a base.

SKOLNIK: But could you pull the urethanes out of the two phase system?

MORGAN: No. Not very many of them.

SKOLNIK: I noticed that most of your publications are on 610 polyamide. Why did you choose that so much for your publications?

MORGAN: That's an easier acid chloride to handle. It's easy to purify and it doesn't deteriorate as rapidly. And it's better for demonstrations because the solution stands up longer.

SKOLNIK: And they were always with the water and the carbon tetrachloride for your two phases.

MORGAN: In the beginning. We've investigated a lot of solvents.

SKOLNIK: When you did it for the elementary grades, what did this mean to the kids? Or was it just a matter of magic to them?

MORGAN: It's mostly a matter of magic.

SKOLNIK: How did you get them to comprehend?

MORGAN: We tried to tell them what we were doing. We told them that the material we were making was a nylon and it was similar to regular nylon in its fundamental characteristics. Then we actually tried to explain to them what a polymer was.

SKOLNIK: Did you put the polymers on the boards for the kids?

MORGAN: Yes. I'm sure they didn't understand. I have a little

experiment that I also showed them which had magnets in it and that's in one of those publications (12). You have a piece of balsa wood and two bar magnets with the two south poles facing out and then another one with the two north poles pointing out. You make a whole bunch of these and then you put them all together and they come out a chain of white, black, white, black. You tell them that these things react with each other but not with themselves.

SKOLNIK: You could also use repulsion instead of attraction. But in your demonstrations you preferred the attraction instead of the repulsion.

MORGAN: Well that's the one that I made up. I drew a diagram of the other kind. We didn't ever make the models for that. We had pop beads and things like that to try to give them the idea of a polymer chain.

SKOLNIK: Actually, most of your fame rests on the interfacial condensation.

MORGAN: A lot of it does, although perhaps it should be broadened to low temperature polycondensation in general. Some of it has to do since then with the association with Kevlar and the high tenacity fibers. Kevlar is an aromatic fiber based on an aromatic amide which has a very high tenacity and a high modulus.

SKOLNIK: You used the terephthalamide?

MORGAN: Yes. It's a polyphenylene terephthalamide (12a). It's used as a reinforcing fiber for plastics and rubbers.

SKOLNIK: But it's not used in tires.

MORGAN: No, not primarily. It's used mostly in reinforcing plastics--bulletproof vests, etc.

SKOLNIK: So you think Kevlar is responsible for your fame as much as interfacial condensation.

MORGAN: It's been the basis for some of the awards or some combination of the two.

SKOLNIK: Your first award was interfacial...

MORGAN: Yes. The citation includes the phrase, "..discovery and development of low temperature condensation polymerization." However, my lecture, and the other contributions to the symposium, was on aromatic polyamides (12b).

SKOLNIK: That was the polymer division's Polymer Award for 1976. That was the year that the ACS was one hundred years old. You were at the New York meeting. Did you read the book, A Century of Chemistry (13)?

MORGAN: Yes. I have a copy of it somewhere.

SKOLNIK: You haven't read it cover to cover then?

MORGAN: No.

SKOLNIK: Well, I have many times. Of course I wrote it.

MORGAN: That would do it.

SKOLNIK: How do you feel about present day chemists and the present day education of chemistry?

MORGAN: I haven't had first hand experience with chemists for ten years in the sense of working with them and assessing their education. But those that I trained--I trained a lot of chemists in the last few years that I was with the company--had sound backgrounds. I was the person who broke them in and got them indoctrinated in polymer chemistry and weaned them away from pure organic chemistry.

SKOLNIK: Was Dave [David F.] Eaton one of the people you trained?

MORGAN: No.

SKOLNIK: He worked in fluorine chemistry at Du Pont.

MORGAN: I think he's in Central Research. At least that's where he was. I didn't have him but I had a lot of others. Most of

them were very well trained and adapted very well.

SKOLNIK: They were very well trained in the mechanistic aspects of chemistry.

MORGAN: Yes. Not very many of them had polymer chemistry.

SKOLNIK: Well you didn't either until you came to Du Pont except for cellulosics.

MORGAN: Sure. That's not entirely necessary.

SKOLNIK: There are still only about twenty colleges where you can learn polymer chemistry in the United States out of several thousand. Does that concern you?

MORGAN: I think from the polymer point of view it's important and the fact that such large proportions of chemists do eventually work on polymers. I think polymer chemistry ought to be part of the curriculum. More schools should be teaching some polymer chemistry.

SKOLNIK: The University of Delaware does not have a course in polymer chemistry. They did when Betty Dyer was still on the faculty. Since she retired it's no longer given. That doesn't mean professors don't work in polymer chemistry but there is no course in it. You can't do chemistry without polymer chemistry, particularly not the analytical part of it or the physical chemistry part.

MORGAN: A chemist can't learn everything.

SKOLNIK: How many children do you have?

MORGAN: Two. A daughter and a son.

SKOLNIK: Are they chemists?

MORGAN: No. My son is a physical education teacher and my daughter went to the University of Delaware for two years and studied art. But she has since gotten married and had three children.

SKOLNIK: So you're a grandfather three times over. Is your son married?

MORGAN: No. He has been married but he's divorced now. He has no children.

SKOLNIK: Does he teach in the high school system or in college?

MORGAN: In high school and elementary school in the Concordville area. He has taught here in West Chester and he has also taught in Florida. He was down there for a number of years.

SKOLNIK: So your son lives with you?

MORGAN: Yes.

SKOLNIK: Where does your daughter live?

MORGAN: She lives in Willistown which is not far away.

SKOLNIK: Aren't you lucky. I have a daughter in New York and one in California. Where do you find the greatest satisfaction now since you've been retired?

MORGAN: I'm doing a number of things. I'm still in consulting mostly with Du Pont. I've consulted with other companies as well.

SKOLNIK: Do you have to get permission from Du Pont before you can consult with other companies?

MORGAN: Not entirely. I do sometimes when the subject is close to their interests. I purposely shy away from things like polyesters where I know too much about the proprietary nature and couldn't comfortably consult there. But there are a lot of areas where I can still consult and not have a conflict. I've worked for many years with the Boy Scouts and I'm still working with them. I'm chairman of a troop committee in West Chester. I collect antique tools and I've been writing about that. I've been collecting mostly for the purpose of writing. I belong to a number of societies and travel to their conventions.

SKOLNIK: How about the American Chemical Society? Are you going to New York in April?

MORGAN: No I'm not. I'm writing some chemistry. I have two reviews in encyclopedias (14). I have another one on azomethines that's being revised and is going into Macromolecules (15).

SKOLNIK: What sort of azomethines are you talking about?

MORGAN: These are polymeric. They're aromatic polymers. Methylphenylene diamine combined with terephthalaldehyde is a prime example. It's has all aromatic rings with one methyl substituent.

SKOLNIK: You have a reaction with the aldehyde groups to give you the methine and the diamine gives you your azo group.

MORGAN: Right. Well, it has an -N=CH- linkage. These polymers are liquid crystalline as melts. We've made very high tenacity fibers.

SKOLNIK: Du Pont's not interested in that?

MORGAN: They investigated it and it was scaled up. They obtained a couple of patents on it (16). But they're not going to make it. We've made fibers from it. There are some other problems. There's a hydrolytic stability problem. Of course they're highly colored too, but that doesn't really matter.

SKOLNIK: Not if you put them in tires.

MORGAN: That's right. So I'll probably be writing some more chemistry and some more review articles.

SKOLNIK: You've actually never been active in the American Chemical Society, either in the Delaware section or nationally?

MORGAN: Not extremely active. I was chairman of the Polymer Topical Group of the Delaware Section.

SKOLNIK: That was near the beginning of its formation.

MORGAN: Yes, in the late 1950s. And I worked with you on nomenclature for awhile.

SKOLNIK: That goes way back to 1950.

MORGAN: Later on I was on the nomenclature committee with [Norbert M.] Bikales. He's at the National Science Foundation as a program coordinator. He has charge of the funds especially in the polymer area. I've been on the awards committee for the ACS National Committee and for the Polymer Division. I was counselor for the Polymer Division.

SKOLNIK: But never counselor for the Delaware section?

MORGAN: No. I haven't done that.

SKOLNIK: Well that's too bad. I think we could have used your talents. Is there anything that I should have covered that I didn't cover? How did your wife keep busy while you were at Du Pont experimenting with the polymers?

MORGAN: She put up with it. She was in the Brownie Scouts and in the scouts with me. We put on round tables for the scout leaders. Also, she did a lot of other community volunteer work. She had a lot to do raising the kids, and we traveled a lot.

SKOLNIK: Were you traveling with the company?

MORGAN: I traveled more after I retired than I did before because I could do things on my own.

SKOLNIK: The work at Du Pont didn't force you to travel?

MORGAN: Not very much. Once I retired I could go to all kinds of meetings. IUPAC meetings. I was in Sweden for a week teaching polymer chemistry. That was an interesting experience. I spoke in English and they understood it very well. Then I went to Japan for an IUPAC meeting and traveled around there. I was chairman of a Gordon polymer conference in 1974. I went to Gordon conferences for years.

SKOLNIK: You always saw Harold Spurlin there too?

MORGAN: Oh yes. Spurlin used to come.

SKOLNIK: He was my first boss at Hercules.

MORGAN: Well, it was nice to talk to you.

SKOLNIK: I bet you haven't talked this much chemistry for years.

MORGAN: Well, I haven't talked about it as a thing in the past. I did an interview with David Hounshell awhile back (17). That has a fair amount of Du Pont proprietary information on it.

SKOLNIK: Actually, there's not much of a relationship between the two tapings?

MORGAN: No.

SKOLNIK: If you had not gone into chemistry, what would you have been? A carpenter?

MORGAN: I could have been. I wanted to be a mineralogist or a mining engineer.

SKOLNIK: Maybe if you had gone to a different college you might have done so.

MORGAN: I've always been interested in mineralogy. In fact, I've given talks at the schools on that.

SKOLNIK: Do you have a good collection of rocks and minerals?

MORGAN: Yes.

SKOLNIK: Do you have a collection of rocks that would demonstrate the types of rocks we have in Delaware?

MORGAN: I think so. I have some Delaware rocks and I have some that would be typical of what would be in Delaware. I just went down to the mineral show in Claymont last week. I belong to a couple of mineral societies. If you have some need for a talk like that, I'd be glad to help you with it.

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