CHEMICAL HERITAGE FOUNDATION

ARTHUR I. MENDOLIA

Transcript of an Interview
Conducted by

James J. Bohning

at

Titusville, New Jersey

on

12 November 1998

(With Subsequent Corrections and Additions)

Arthur I. Mendolia

CHEMICAL HERITAGE FOUNDATION
Oral History Program
FINAL RELEASE FORM

This document contains my understanding and agreement with Chemical Heritage Foundation with respect to my participation in a tape-recorded interview conducted by James J. Bohning on 12 November 1998.
I have read the transcript supplied by Chemical Heritage Foundation.

1. The tapes, corrected transcript, photographs, and memorabilia (collectively called the "Work") will be maintained by Chemical Heritage Foundation and made available in accordance with general policies for research and other scholarly purposes.

2. I hereby grant, assign, and transfer to Chemical Heritage Foundation all right, title, and interest in the Work, including the literary rights and the copyright, except that I shall retain the right to copy, use, and publish the Work in part or in full until my death.

3. The manuscript may be read and the tape(s) heard by scholars approved by Chemical Heritage Foundation subject to the restrictions listed below. The scholar pledges not to quote from, cite, or reproduce by any means this material except with the written permission of Chemical Heritage Foundation.

4. I wish to place the conditions that I have checked below upon the use of this interview. I understand that Chemical Heritage Foundation will enforce my wishes until the time of my death, when any restrictions will be removed.

Please check one:

a. ✓ **No restrictions for access.**
NOTE: Users citing this interview for purposes of publication are obliged under the terms of the Chemical Heritage Foundation Oral History Program to obtain permission from Chemical Heritage Foundation, Philadelphia, PA.

b. _____ **Semi-restricted access.** (May view manuscript. My permission required to quote, cite, or reproduce.)

c. _____ **Restricted access.** (My permission required to view manuscript, quote, cite, or reproduce.)

This constitutes my entire and complete understanding.

(Signature) A I Mendolia

(Date) 8/20/99

Revised 11/24/1998

Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 19106

ARTHUR I. MENDOLIA

1917 Born in Brooklyn, New York on 6 May

Education

1941 B.S., Chemical Engineering, Case Institute of Technology

Professional Experience

E.I. DuPont de Nemours and Company, Inc.

1941-1954 Research Engineer, Electrochemicals Department
1954-1956 Assistant Director of Research, Electrochemicals Department
1956-1958 Assistant Director of Sales, Electrochemicals Department
1958-1966 Assistant General Manager, Electrochemicals Department
1966-1970 Assistant General Manager, Explosives Department
1970-1973 Vice President and General Manager, Explosives Department

U.S. Government

1973-1975 Assistant Secretary of Defense for Installation and Logistics

Halcon International

1975-1978 President
1978-1980 Chairman, Oxirane International

CasChem, Inc. (later, Cambrex Corporation)

1981-1987 Co-founder, Chairman of the Board, Chief Executive Officer, Chairman of the Executive Committee.
1987-1995 Director of the Board, Cambrex Corporation

Honors

1979 Case Alumni Association Gold Medal Award as Outstanding Alumnus
1990 Winthrop-Sears Award for Entrepreneurship (with C.C. Baldwin)

ABSTRACT

Arthur Mendolia begins the interview with a discussion of his family and childhood. After graduating from high school in Youngstown, Ohio, Mendolia entered Case Western Reserve University in 1934, majoring in chemical engineering. Financing education during the Depression was difficult, and Mendolia worked at Youngstown Steel Door Company to make money. He received his B.S. in 1941 and began to work at DuPont as a research engineer. Mendolia spent thirteen years in DuPont's adiponitrile plant in Niagara Falls, occasionally commuting to a plant Charleston, West Virginia. In 1954, Mendolia was named Assistant Director of Research of DuPont's Electrochemicals Department, a position he held for two years before moving into sales as the Assistant General Manager. In 1966, Mendolia became the Assistant General Manager of the Explosives Department. There he sold DuPont's chemical process for making acrylonitrile to Amoco Chemical Company. DuPont recognized Mendolia's exemplary management skills and promoted him to Vice President of Explosives in 1970. In 1972, Mendolia met Ralph Landau while negotiating a purchase of ethylene glycol for DuPont. Later that year, DuPont recommended Mendolia for a position in the U.S. Department of Defense [DOD]. There, Mendolia learned more about management, organization, finances, and worked personally with President Gerald Ford. After two years with the DOD, Mendolia became president of Ralph Landau's company, Halcon International. Later, he became Chairman of Oxirane, a Halcon and Arco joint venture. With Oxirane, Mendolia set up branch offices in Eton, England, and Houston, Texas, and set up Oxirane's R&D department. He worked to establish uniformity and standards within the company. In 1981, Mendolia and Cy Baldwin bought their own chemical company, CasChem, Inc., a castor oil and polyurethane production company. Then Baldwin and Mendolia purchased Cosan, a biocide company, in 1985. In 1987, these companies officially had their names changed to Cambrex Corporation. Mendolia concludes the interview with a discussion of purchasing chemical companies, management issues, his family, and hobbies.

INTERVIEWER

James J. Bohning is currently Visiting Research Scientist at Lehigh University. He has served as Professor of Chemistry Emeritus at Wilkes University, where he was a faculty member from 1959 to 1990. He served there as chemistry department chair from 1970 to 1986 and environmental science department chair from 1987 to 1990. He was chair of the American Chemical Society's Division of the History of Chemistry in 1986, received the Division's outstanding paper award in 1989, and presented more than twenty-five papers before the Division at national meetings of the Society. He has written for the American Chemical Society News Service, and he has been on the advisory committee of the Society's National Historic Chemical Landmarks committee since its inception in 1992. He developed the oral history program of the Chemical Heritage Foundation beginning in 1985, and was the Foundation's Director of Oral History from 1990 to 1995.

TABLE OF CONTENTS

INTERVIEWEE: Arthur I. Mendolia

INTERVIEWER: James J. Bohning

LOCATION: Titusville, New Jersey

DATE: 12 November 1998

BOHNING: Let's begin with when and where you were born.

MENDOLIA: Well, I was born in Brooklyn, New York, on May 6, 1917, and I left Brooklyn before I knew it was on Long Island! [laughter]

BOHNING: If you could, tell me something about your parents and your family background.

MENDOLIA: My father was a dress and coat designer. The reason we moved from Brooklyn to Cleveland, Ohio, is that my dad got a job in Cleveland. But my mother hated to be away from her family, and after about three or four years, we moved back to Brooklyn. While my father was looking for a job, he caught pneumonia and died. I was seven years old. So I have the dimmest recollection of my father.

BOHNING: So you moved temporarily to Cleveland when you were very young?

MENDOLIA: Yes, very young. I started grade school there. As a matter of fact, my wife and I have often kidded about that. We probably went to the same library, because there was a Doan Library somewhere nearby, and my wife used to go there; but we didn't know each other then.

BOHNING: Where in Cleveland was this?

MENDOLIA: This was on Superior Avenue. As a matter of fact, it was near Magnolia Drive, so if somebody couldn't spell "Mendolia," I'd say, "Think of Magnolia." [laughter] It was right near what's now, I think, Martin Luther King Road, which goes right up to the Case [Western Reserve University] campus.

BOHNING: So very early in your life you were associated with Case and didn't know it.

MENDOLIA: [laughter] Well, you know, it's funny. We lived on East 99th Street—I've never gone back there. The guy who lived next door to us was a Case student and a track man. He went to work for Sohio. When I had to make a decision on where I should go to college—I lived in Youngstown, Ohio, when I went to high school—Carnegie Mellon [University] was 65 miles to the east, and Case was about 65 miles to the north. I went to Case mostly because it was the school that my next-door neighbor went to probably fifteen years before. His name was Dudley Crawford.

BOHNING: Well, before we get to Case, let me back up a little bit. So you moved back to Brooklyn when you were how old?

MENDOLIA: Seven years old.

BOHNING: How long did you stay in Brooklyn?

MENDOLIA: I stayed in Brooklyn for probably about four years. Then my mother remarried, and guess where we went back to? We went back to Cleveland. [laughter]

BOHNING: Was there any reason why they ended up going back to Cleveland?

MENDOLIA: No. Well, you know, that's something of which I don't have a good recollection. My stepfather was a broker, and he earned his living in Cleveland. Now, how he got hooked up with my mother, I really can't recall. But we went to Cleveland, and this was during the Depression. At one point in time, he had a tough time earning a living, so we moved to Youngstown, Ohio, which is where I finished high school. It was there that I made a decision to go to Case instead of Carnegie Tech.

BOHNING: Do you have any recollections of your grade school back in Brooklyn or anything that influenced you during that time?

MENDOLIA: Yes, you know, I remember that more than anything else, because I had a couple of good teachers. There was a fellow named Mr. Gounod. He made a lasting impression on me. He was an excellent teacher. But I only went to about the fifth grade in Brooklyn. Then we moved to Cleveland. I finished grade school in Cleveland, started junior high, and we moved to Youngstown, Ohio. So I finished up my junior high education in Youngstown and went to high

school there. But it was an interesting period. Why? Because there were World War I babies coming along, and the high school that I went to had two sessions a day. I went in the morning. I had all afternoon and there was no homework and no tests. When I went to Case, I got the shock of my life. Everyone expected me to work! [laughter] The truth was, I really hadn't ever had to study before. It was a tough transition.

BOHNING: Did you have any science exposure in Youngstown?

MENDOLIA: Yes, I took chemistry. I haven't been back to Youngstown since about 1946, and it's changed a lot, I understand. It used to be a steel town like Bethlehem, Pennsylvania. [laughter]

BOHNING: Yes, it used to be.

MENDOLIA: I saw somebody last week that went there about two or three years ago. He said that the steel mills have been leveled. The Mahoning River is no longer polluted. It's there and it's clean.

BOHNING: Now, you said your Case decision was based on your next-door neighbor. Was that a neighbor in Youngstown?

MENDOLIA: No, a neighbor in Cleveland when I was probably under seven years old.

BOHNING: So it dates way back to that early time, then.

MENDOLIA: Yes. Well, I remember going to see Dudley Crawford run. I don't remember whether he ran a quarter mile or a mile. I went to the Case campus to see him run. This had to be in 1923. His family was very friendly. We used to keep in touch with the Crawfords. We did while we were in Youngstown.

BOHNING: Did you enter Case in 1937?

MENDOLIA: In 1934. I graduated in 1941 because I ran out of money a couple of times.

BOHNING: I was going to ask you how you financed this during the Depression.

MENDOLIA: It was tough, very tough. Jobs were difficult to get in Youngstown because the lines to the employment office were long. The jobs would be filled before you ever got to the end of the line. But a next-door neighbor of ours, I think, worked for Youngstown Sheet & Tube, and they had a subsidiary called Youngstown Steel Door that made boxcars. He helped me get a job at the Youngstown Steel Door Company. I think the first day I went to that job it was 17 degrees below zero [laughter] and there was no heat in this building, and the noise! When I came home, my mother cried. She said, "My son has oil all over his face!" [laughter] But you know it's hard to tell kids how tough the Depression was. It really was. I think unemployment in Youngstown must have been 30 percent. So it was a tough struggle.

BOHNING: When you first got to Case, you said it was a shock.

MENDOLIA: I had to work! [laughter] Had to do homework. Had to go to class all day! [laughter] Just like Lehigh [University].

BOHNING: Had you selected a major when you went?

MENDOLIA: Yes. You know, it's interesting to me because, as I told you, I heard Dr. Lisa [Saunders] Boffa from Exxon [Chemical Company] pointed out that chemical engineers are getting paid more than chemists. Well, I don't know how I got this little pamphlet in the early 1930s, which said that chemical engineers were the best paid. [laughter] Here, sixty-five years later, they still are! Chemistry appealed to me, so I took chemical engineering. You had to make up your mind early at Case what you were going to do.

BOHNING: What appealed to you about chemistry? You said you had a course in high school.

MENDOLIA: Well, I liked chemistry, and I still like it. Organic chemistry has always appealed to me. What about it did I like? I really don't know. But it still appeals to me. I still read the American Chemical Society [ACS] News edition, and I read *Science* magazine, and it's always interesting to read about the complexity of molecules today.

BOHNING: Did you have any mentors at Case that influenced you?

MENDOLIA: Yes, I did. The fellow most influential in my life was Dr. Carl S. Prutton. He was the head of the Chemical Engineering Department. I became a good friend in his latter years after he left Case. I think he headed up FMC [Corporation]'s chemical business and Olin [Corporation]'s chemical business.

I've got to tell you a story that I've never forgotten. I had an uncle who lived in Niagara Falls and he steered me to the Electrochemicals Department [El Chem] of DuPont [E.I. DuPont de Nemours and Co., Inc.]. Don Notman, who was eventually the general manager of El Chem, was the plant manager. I interviewed at DuPont in the morning and I had a date to interview Olin in the afternoon. Well, DuPont offered me a job in the morning and I cancelled the date in the afternoon. I've often wondered what life would have been like if I'd gotten to Olin in the morning. Those are the decisions that determine your future. [laughter]

Dr. Prutton was my mentor. It was interesting because he was listed, I think in 1937, on the only IRS [Internal Revenue Service] list they've ever put out of the thousand highest paid men in the United States. Carl Prutton was one of them. He was a consultant for Dow [Chemical Company] and for Lubrizol [Corporation]. He held a lot of patents. He made about fifty thousand bucks in 1935 or 1936, which was a lot of money! He was a very astute guy. He could create chemical engineering problems, and he knew how to solve them. The professors after that, some of whom had never been in industry, couldn't generate the problems, let alone solve them. You saw the difference between the men who had a lot of experience in industry, and ones who didn't have any.

BOHNING: What was Case like in the 1930s?

MENDOLIA: In the 1930s it was a small school. I think there was about a hundred and twenty-five in my graduating class. When I took my first freshman physics class, the professor, Dr. Dayton Miller said, "Look on either side of you. One of you is not going to be here next year!" [laughter] He was a professor of physics and an amateur meteorologist. He said, "If you're asked to forecast the weather, just say 'Tomorrow is going to be just like today,' and you've got a 50 percent chance of being right!" [laughter] You know, with all the computers today, weather is such a micro deal that it's hard to forecast the weather.

But it was a small school. Well, it's not a lot bigger now, even though it's part of Case Western Reserve. My wife went to Flora Stone Mather College, the women's college of Western Reserve University. It was fairly common in those days for a Case guy to marry a Mather girl! [laughter] Western Reserve was our vicious rival, and on Thanksgiving Day we played each other. Nobody plays on Thanksgiving anymore.

I've got to tell you another interesting story. Ohio State [University] in the 1930s lost two games in two years but lost both games to [University of] Michigan. Michigan fired the coach. Western Reserve hired him and he brought all of his "plug uglies" to Cleveland. I got to know a few of the football players. Western Reserve went to the Sun Bowl, I believe, in 1936

or 1937. That was unprecedented. They just cleaned up the league. Indeed, a new league was formed called the President's League. It had Denison [University] and Oberlin [College], where students played against other students. [laughter]

BOHNING: So you were in and out, you said, because of financial problems. Would you go a year and stay out a year, basically?

MENDOLIA: Yes.

BOHNING: Was there any financial assistance from the university?

MENDOLIA: No. You know, my kids ask me what the tuition was. I think tuition was only about three hundred dollars, but that seemed like an enormous amount of money, especially when I think, as a steelworker, I was paid about seventy cents an hour. Before Walter Reuther, who was the head of the United Steelworkers, seventy cents was high.

BOHNING: That's right.

MENDOLIA: And you were lucky to have a job.

BOHNING: Did you get any help from your mother or your stepfather?

MENDOLIA: No, but I got a little help from my deceased father. He left an insurance policy in trust when he died. But that didn't last very long. A thousand dollars in those days was a lot of money! [laughter]

BOHNING: Now, you indicated that you had scheduled only two interviews?

MENDOLIA: That's all. DuPont was desperate. This was in 1941. Hell, they'd hire a body if it was warm because people were leaving. [laughter] To this day, I've often wondered how I got hired. The plant in Niagara Falls made metallic sodium. I interviewed with about six or seven supervisors, and at least two of them asked me, "How do you make sodium?" I was electrolyzing an aqueous salt solution instead of molten salt. You know, I was as wrong as could be! [laughter]

BOHNING: Well, somewhere I read that there was an elective at Case in electrochemical engineering. Did you take that course?

MENDOLIA: At Case I took the electrochemical elective. I worked on a senior problem for the recovery of sodium from sodium-filled valves, which were used during the war. The Army had many used valves. They wanted to recover the sodium. Shortly thereafter, I went to work for the Electrochemicals Department of DuPont, but I never worked on an electrochemical process the entire time I was at the plant. I spent thirteen years in what was called the South plant, which primarily made organic chemicals.

BOHNING: Since Herbert H. Dow was a Case graduate, I wonder whether that electrochemical engineering was a Dow legacy because Dow and Case had a very strong connection.

MENDOLIA: It could very well be. They had a very strong relationship. We learned a lot about Dow chemistry and the brines they had up at Midland, Michigan. The physical chemistry was done at Case for the separation of magnesium from the Midland brines.

BOHNING: So you were aware of Dow as a chemical company?

MENDOLIA: Yes, there was a strong relationship between Dow and Case for a long time. There still is. I know it is because I was on the Case Board of Governors for about five or six years, and one of the board members was a Dow guy who'd grown up in the agricultural business at Dow. He felt very strongly that the engineering group, which was then part of Western Reserve, really ought to have a preferred status. If not, they were going to lose donations from Case graduates. The President of Case was Dr. Agnar Pytte, who came from Dartmouth College, where he had been Provost. Pytte was persuaded to put the issue to a vote of the faculty. The plan was to put the School of Engineering inside the School of Liberal Arts and Science. My reaction was "the odds of that succeeding are negligible."

Well, the faculty voted for it by about 98 to 2. I didn't think you could get a faculty [laughter] to vote on anything 98 to 2. To this day—well, this was probably about eight or nine years ago—it's the Case School of Engineering, part of the Liberal Arts College. It makes a lot of sense because you don't have a third of the guys leaving after freshman year. If a student said, "engineering or math are too tough," they could just switch and go to the liberal arts end of the school and go on to get a law degree or a medical degree.

BOHNING: When you interviewed at DuPont, what did they say that you were going to do? Did they indicate Niagara Falls would be the place where you would be assigned?

MENDOLIA: Well, yes. DuPont was fragmented in those days. As a matter of fact, departments really ran their own show with very little guidance from the top. So, you knew if you were going to get a job, you were going to go to Niagara Falls. So that's where I got a job, and I started in the research laboratory. I liked research. But I went into a lab with thirteen people and I was the only bachelor of chemical engineering. Eleven of them were Ph.D.'s, one master's, and me. After about a year I said, "this is not the place for me." So I pushed to get into the production end of the business, and it took a year of prodding the Human Resources guy, or whatever he was called in those days, to get them to switch me into production. But I finally got a new assignment after about a year.

BOHNING: Before you move on to the production part, what was it like in this research group? What were you doing?

MENDOLIA: I enjoyed it. DuPont in those days was interested in making vinyl chloride. So one of the things I did was make polyvinyl chloride on a semi-works scale. I probably made the emulsion in a three or four hundred-gallon vessel. I also made the co-monomer, which was diethyl fumarate. Indeed, I'll never forget an incident. We made diethyl fumarate from maleic anhydride and ethyl alcohol. The maleic anhydride came in one chunk in a one hundred pound can. I used to break it up. Well, the first time I broke it up, I went home that night and I couldn't read. Then I realized why maleic anhydride was called toxilic anhydride. It paralyzed the nerves in your eyes. [laughter] I said, "I'm blinded for life!" Fortunately, the next morning I regained my vision. As the chemical engineer in the laboratory, I did the scale-up work. I did the semi-work scale. Adjacent to my semi-works unit, a co-worker was making acrylonitrile from acetylene and HCN. The chemist could smell HCN, and he'd blow a siren so you'd have to run down. By the way, some people can detect HCN and other people can't. But I learned to detect it pretty fast. [laughter] But I did the scale-up work, and I did the pilot plant work. I did it alone. Because DuPont was losing people to Hanford [Engineering Works], but none of us knew where these people were going. They were going to Project TNX or something like that. DuPont at that point also built a Chemical Warfare Service plant in Niagara Falls. None of us knew what the Chemical Warfare Service produced. We learned after the war that they were making a mustard gas decontaminant. You went into a movie theater and you could smell the chemical and you knew they worked at the Chemical Warfare Service plant! [laughter]

BOHNING: You were the only chemical engineer in that research lab?

MENDOLIA: That's right.

BOHNING: Everybody else was a chemist.

MENDOLIA: Yes, chemists. A bunch of smart guys. All organic chemists. The guy who was the head of that group was Oliver Cass. DuPont, while it thought of itself as a company of inventors, had never honored its inventors. Somewhere around forty years ago they had a dinner for the people who had made the most inventions. Dr. Oliver Cass had about one hundred and five patents. A bright and creative guy.

We used to make tetrachloroethane and trichlorethylene. I had to analyze it. It took me a week to analyze it, and nobody gave a damn about the answer. [laughter] Now you stick it in a gas chromatograph and the answer comes out in a few seconds. [laughter] So the world has changed a lot.

[END OF TAPE, SIDE 1]

BOHNING: World War II started shortly after you arrived there.

MENDOLIA: It did.

BOHNING: I was curious about how you stayed out of the draft, because of your age.

MENDOLIA: Well, DuPont tried to get me deferments. When I was in production, one of the things I worked on—because they were losing people at a great rate, because they couldn't get deferments—was a Chemical Warfare Service plant on the Ohio River, near Moundsville, West Virginia, about 30 miles south of Wheeling. Hooker Chemical Company had developed a process for making hexachloroethane, but they had done it on a laboratory scale. Our job was to scale it up to a two thousand-gallon, glass-lined reactor and produce it. It was the pressure chlorination of perchloroethylene to hexachloroethane. Well, that was a tough process. All of the operators were hillbillies from West Virginia and had never been inside of a chemical plant. The chlorine leaks were incredible! The plant structure was built out of wood and a cemetery was a few yards from the plant. There were two of us from Niagara Falls whose job it was to get the process running. We both shared one room in the hotel about 15 miles away in Moundsville, West Virginia. The only heat in this room was a gas heater, and I hated to go to sleep with a gas heater going.

Well, the chlorine leakage in the plant was so bad in the first couple of weeks that you had to wear a gas mask twelve hours a day. We didn't know how to seal the openings on the vessels. I'll never forget it. I may have mentioned this in my speech (2). An operator came up

to me and his eyes were full of tears. I pointed to a pair of gas goggles, and I said, "Put those goggles on." He put them on and four or five minutes later he said, "These don't work!" He hadn't put the lenses in the gas goggles! That showed you how little these people knew about the chemical business. DuPont trained the operators. It was a tough job.

I got married in 1943 and we had a child in 1944. I think the magic age for deferment was twenty-six or twenty-seven, and I became that in 1944. I tried to volunteer, but my vision was poor. As a matter of fact, the first time I found out I couldn't see was when I went the Grosse Isle Naval Air Station. I tried to get in and the guy gave me a few depth-perception tests, and said, "Go see your eye doctor." [laughter] So I figured, what the hell? I'd wait until I got drafted. I never got drafted, because I think twenty-six or twenty-seven was the magic age. So I didn't serve in the military.

BOHNING: You finally moved into production in 1943. Did you go down to West Virginia right away? Was that one of your first assignments?

MENDOLIA: I can't recall exactly, but it was probably six or eight months after I'd been in production. Probably the end of 1943. It was winter. All I know is it was damned cold and I wasn't there too long. Probably six weeks.

BOHNING: How did you compare being in production as opposed to being in research?

MENDOLIA: Well, you know, this is an interesting story because I liked research. But the likelihood of me getting a Ph.D. was close to zero in those days. I liked production because I got a chance to use my skills. As a matter of fact, one of the things I was asked to do when I first got into production was to build a methylene chloride plant. I had to build it from scrap and junk. This was a small plant by today's standards. We used four-inch pipe. But the four-inch pipe out in the yard was full of debris. It turned out I hadn't taken the heads off the heat exchangers that I had selected and they were also full of junk.

Hydrochloric acid [HCl] had seeped into the ground so that some of the columns in this building were not perfectly vertical. I had assumed that the columns were vertical, and the pipefitters said, "This guy doesn't know his ass from a hole in the ground. He doesn't even know how to measure pipe." When they went to put up the pipe, which was pre-cut, it didn't fit. [laughter] Well, we got that damn plant built.

I don't know whether you've ever fooled around with HCl, but HCl in those days was made by introducing hydrogen and chlorine into the bottom of a brick-lined cylinder. Then you stuck a torch in there, and you'd get a flame. Every once in a while that flame would blow right through the opening in which we introduced the torch. [laughter] HCl was used to make methyl chloride, which was a solvent in the production of butyl rubber. We made a lot of it for Esso,

which had a plant in Baton Rouge, Louisiana. Methylene chloride was a key raw material for the war effort, and we made that, too. I enjoyed production.

BOHNING: I've often wondered, when I've talked to chemical engineers who have an undergraduate background and then, all of a sudden, you're building a plant from scratch, how much of your background helped and how much did you have to learn on the spot?

MENDOLIA: Well, I had to learn a hell of a lot. I made a calculation on a partial condenser. I went through [John Howard] Perry's *Chemical Engineering Handbook* (3) and learned how to make the calculation. I brought it to my boss at the time, he looked at it, and said, "Well, let's build a condenser that's twice as big as you calculated." I knew damn well he didn't believe the calculation! [laughter] So that told me a lot about the practicalities of decision-making. [laughter]

BOHNING: You've also commented in that talk to the Stanford [University] students (2) about your first exposure to production accounting and incentive pay.

MENDOLIA: Yes. Many parts of DuPont had installed a system called the "Bedaux System," which was an incentive system that paid the operators a wage that depended on output and yield. DuPont had a bunch of men that timed jobs. When I first went into production, one of my jobs was to do the accounting. I learned that the yield was absolutely level. I said, "This can't be." I found out that the yield was tied to the workers' compensation and the supervisors didn't want to change that compensation, so they'd jigger with the inventory. I learned why that was so. Early in the post-war period, DuPont bought itself out of the Bedaux System. It cost them about twenty-five million bucks, and in 1946 or 1947 that was a lot of money! I think the Chambers Works was on that system, and it had five thousand employees. It taught me a hell of a lot about the inadequacies of man and supervision. The willingness to let a system continue because there'd be more problems if you had the yield go up and down and the pay go up and down. Interesting.

As a matter of fact, about that time, I read a book by Samuel I. Hayakawa called *Language in Action* (4). I gave a few talks on the art of semantics, and that probably influenced me the rest of my life. Even to this day, I look to see who the author is of a paper, whether it's the *New York Times* or whatever, because then, if I know him, then I know what his biases are. That leads you to read with skepticism.

I went to Princeton [University] about four or five years ago. I took three courses, and one of the guys I got to know was a computer science major. He took molecular biology with me. I see him about every six months. He's out in San Francisco, and I told him about *Language in Action*. He found a copy of the book. Hayakawa was a professor, I think, at San Francisco State University and later became a Senator from California. But it was one of the

first books on semantics. A simple little book and illustrated with cartoons. But as I say, it influenced the rest of my life.

BOHNING: You've commented about how important it is for engineers to be able to communicate, but to be terse. What was your experience with that?

MENDOLIA: Well, the job I had after I was a production supervisor was a development supervisor. I can't recall the title. We had to write weekly reports. I was a lousy writer, but my boss, Bill Vining, had the persistence and the willingness to edit what I wrote. I learned more from this guy about how to write a few lines that said exactly what you wanted to say. I think that probably influenced the rest of my life. I've been asked by my children, "How did you ever accomplish your goals?" I'm not sure. You really don't know. But I think some part of it has to do with the way I write, and that was taught to me by Bill Vining. When I look at my writing in college, it was terrible. [laughter] Bill Vining had the patience, insight, and skill to work on your material until you got it right. I learned a lot from his editing.

BOHNING: Is that a common trait of supervisors or was he unusual?

MENDOLIA: He was unusual. At least that's my view. I worked for a fellow who fell asleep while you were talking to him. He probably didn't think he had the time to worry about how you wrote. For Bill Vining, writing was important. He had many engineers and chemists working for him, maybe twenty-five or thirty. He worried about the reports and he wanted to make them terse. Get the key information in the first sentence, and don't write too much, because you had to write a report that had twenty-five or thirty guys writing for it. If you made it too long, nobody'd read it, right? [laughter]

When I went to Case, I had one course in English, one semester of English. That was it. I look at the curriculum today, you get a lot more of that. We had no courses in history. I know nowhere near enough about history. We had one course in economics and it was an elective. All the rest was straight engineering. So is it any wonder that engineers tend to not be really good communicators, unless they're born that way? Some are, but not too many. Engineers hated English. I don't know if you find that to be true at Lehigh. They just didn't like it. They didn't want to take it.

BOHNING: As you just said, it's very important for your career, because if you can't communicate properly, then it's going to make things a lot more difficult.

MENDOLIA: Exactly.

BOHNING: I was struck by the quote, and I think it originated with you, "Be bright, be brief, and be off!" [laughter] I wanted to put that in the record, because I really like that.

MENDOLIA: I think I had that quote on my desk. I don't know where I got it. But I had it on my desk for a while.

BOHNING: What effect did the end of the war have on your career and on DuPont?

MENDOLIA: Well, at the end of the war, DuPont had a lot of technology that they got from ICI [Americas, Inc.], because ICI and DuPont had a relationship that was very close. They exchanged technical information. ICI had developed a process for making adiponitrile from furfural. Furfural was made from corncobs. It's interesting to read the reports that were written by DuPonters that said, "The supply of corn cobs is inexhaustible. We'll never run out of corncobs." I was picked with three other guys to design, observe the semi-works, and supervise the design of the first plant to make adiponitrile [ADN] from furfural. You know, in retrospect, the management made a big mistake. My boss was a fellow who had never been in the organic chemistry side of the plant. He'd been a sodium-production man. The other fellow was a foreman who was probably the most knowledgeable of us all. The other fellow was another chemical engineer who didn't know much organic chemistry. So none of us knew much about what we were trying to do, but we thought we did a good job. It turned out to be a terrible job. The plant start-up took just about a year. But fortunately, nylon was a very successful product, so the management could be patient. As a matter of fact, when we finally got the plant going, we were told to double the size of the plant. Well, by that time, we knew a lot more and we had added a lot of bright fellows.

Indeed, one of the men from whom I learned a lot had been the plant manager at Niagara Falls. He was Bob Hulse, who subsequently left DuPont and started the chemical business at National Distillers Corp. He built the first sodium plant in Ashtabula, and he was an experienced, sharp manager. I'll never forget him. When we were having troubles, we'd work at the plant until about two o'clock in the morning, and Bob Hulse would say, "I'll see you at seven o'clock in the morning?" [laughter] But he was brought in when we were having all these troubles. He had been removed as plant manager because he'd done something wrong with the union. I wasn't quite sure what he really had done. But I learned a lot from Bob Hulse.

As a matter of fact, I'll digress a little bit. Many years later I was with Halcon [International] in New York City and there was a Doug Hulse on our list of employees. I said, "That is an unusual name. I'll have to chat with this guy." Well, his father was Bob Hulse. Doug Hulse lives in Princeton and is an entrepreneur. I met Bob Hulse about thirty years after the adiponitrile startup. He came to visit us at Halcon.

BOHNING: Didn't DuPont have another method of making adiponitrile as well?

MENDOLIA: Yes. The original method made adiponitrile from adipic acid. Then, probably about ten years later, a chemist determined that you could add HCN [hydrocyanic acid] to butadiene in an anti-Markownikoff fashion. He found that you could put CN radicals on each end of the molecule. It took a catalyst. That changed the world for everybody, because it worked like a charm. We had two competitive processes working inside the company. Crawford H. Greenewalt, who was then president of DuPont Company, came to look at our plant one day. I'd given him a tour of the plant and we were looking out a second story window and he said, "You know, I think we're going to shut down your process because the butadiene route has three steps and you have four." [laughter] Within two to four years, we shut down our process.

BOHNING: Crawford was a chemical engineer, wasn't he?

MENDOLIA: Yes, he was. I've got to tell you a story about Crawford. He had a stroke when he was about eighty-seven or eighty-eight years old, and people thought he was going to die. Well, he recovered. I saw him at a Christmas party. I knew that Crawford had graduated from MIT [Massachusetts Institute of Technology] in 1922. I assumed that he was twenty-two when he graduated. So I calculated that he was ninety. I said, "Crawford, you're doing well for a ninety-year-old." He said, "I'm not ninety." He proceeded to tell me that he had graduated from high school when he was fifteen. He graduated from MIT was he was nineteen. I learned more about Crawford's high school [laughter] and college experiences, because I missed his age by three years. [laughter] Bright guy.

BOHNING: Where was the adiponitrile plant? Was this still in the Niagara Falls plant?

MENDOLIA: Yes, it was in the Niagara Falls plant. I was there for thirteen years, and that was an interesting proposition. Why? Because DuPont owned a whole bunch of land that was probably a dump. I hate to mention that word, but it was a dump, and we were given that end of the plant to build a four-step plant, which took a lot of acreage. We had five buildings. Something like that. There was a little pond on part of the property. The first time the land was being graded, the grader was shoving bricks into the pond and many of the bricks had sodium on them. We thought, "It's been out in the air, but probably you get a little sodium oxide on the outside, there's still sodium on the inside." I've never forgotten that. What we built was a pretty interesting plant. This process had been piloted, and in the first step furfural was converted to furan. In the second step furan was hydrogenated to tetrahydrofuran. The third step was the reaction with HCl to form dichlorobutane. The fourth step was the reaction of sodium cyanide and dichlorobutane to produce adiponitrile. Every step had problems galore. I'll never forget. When we were first trying to separate the byproduct salt, we had a rotating

filter. The salt wouldn't build up on the screen. Well, we found out the sodium chloride was like bug dust. Probably a few microns in diameter. It was going right through the screen. [laughter] The process was very corrosive.

In the process for making dichlorobutane, we had Haveg equipment, which was a pain, and glass-lined vessels, but the equipment kept falling apart. We used sodium cyanide because cyanide was made at this plant by an old route. Sodium was put into a vessel that looked like Satan was making sodium cyanide because it had flames coming out of the reactor. So we had all the raw materials there, but again, it was a tough process. The most interesting part of this was that the adiponitrile that we made was shipped to the DuPont plant in Belle, West Virginia, to be hydrogenated to hexamethylene diamine. Now, Belle was the same plant that was making adiponitrile from adipic acid and they told us, "Your adiponitrile is no good." There was a test to determine whether the adionitrile would hydrogenate. Our adiponitrile was different. Another compatriot and I commuted to Charleston, West Virginia, for about a year to persuade the management that you had to treat our material differently. I learned a lot about Charleston, West Virginia. [laughter] But the differences in adiponitrile taught you a lot about organic chemistry. Long before you could identify what those differences are by the analytical techniques we have today. We just didn't have them.

BOHNING: Was there a nylon plant in West Virginia, or was that shipped off again?

MENDOLIA: No. The hexamethylendiamine was shipped to Seaford, Delaware, or Martinsville, Tennessee. As a matter of fact, you reminded me. There was an interesting committee that met probably two times a year that was called the "Nylon Interdepartmental Quality Committee." We used to meet at various plant sites, and we had people from textile fibers that made the nylon, and all the sites that made intermediates. It was a good way to get to know your enemy, your friends, and solve problems. That lasted probably eight or ten years.

[END OF TAPE, SIDE 2]

BOHNING: What time frame was this? Would this have been the late 1940s?

MENDOLIA: Well, the plant started up in the late 1940s, and DuPont also was starting up a titanium oxide plant, by the chloride route, at Edgemoor, Delaware. We were having so doggone many problems, we had DuPont consultants galore. Well, those consultants were shuttling between the titanium tetrachloride process and our plant, and we got to know more consultants because both of the plants had serious problems. The titanium dioxide plant was almost shut down, it was so corrosive. The guy that kept it going was Crawford Greenewalt. He kept saying, "Let's persist in that." It probably took about three years before they ever figured out how to make titanium dioxide via the chloride route, rather than the sulfate route.

BOHNING: Did you stay with this plant until it was shut down, or did you move on?

MENDOLIA: I moved on. In 1954 I was named Assistant Director of Research of the Electrochemicals Department, which was sort of a shock to me because that was a move that pushed me up about three levels. That tended to be unprecedented at DuPont. But I enjoyed research and I had a lot of fun at it. One of the things I did in the early 1950s was recruit Ph.D. chemists and engineers, mostly Ph.D. chemists, because there weren't too many engineers. There was a competitive system inside of DuPont. One could interview with El Chem and Poly Chem [Polymer Chemistry Department], and then get a choice of offers. If he got offers from three or more departments, he could pick the one he wanted to go to, so your job was to attract the candidate to El Chem. I asked them how much they wanted to earn after they were out of school ten years. Most of these guys said, "About ten or twelve thousand dollars a year." I said, "Now what would you like to have?" "Well, I'd like to have a house at the shore, and a house blah, blah." I said, "You're not going to be able to buy that for ten or twelve thousand dollars." Then I'd pull out an annual report. In those days the top tax bracket was about 92 percent. I'd point out to them what you had to earn to get the things you wanted, which opened up the eyes of many Ph.D.'s because they'd never thought about it. They had no reason to think about it. So I wound up getting more Ph.D. chemists that year. As a matter of fact, my boss, Dr. Paul Austin, who was a friend of Speed [Carl] Marvel at [University of] Illinois said that didn't hurt me one iota in terms of making my next move, which was into sales, about which I knew nothing. [laughter] I knew less about sales than I knew about research! [laughter]

BOHNING: Do you know how this appointment came about? You said you jumped three levels, and that was unusual. Who singled you out?

MENDOLIA: Well, that's a good question. I really don't know the answer to that. But I was passed over twice to be the superintendent of the adiponitrile plant and two more experienced guys were put in there ahead of me, and then those guys moved on, and I became the superintendent. Well, what I think I did—I'm not sure of this—is that I was willing to make promises that we could make material at a higher rate than my predecessors would commit to, and we did. I can't remember the number, but I think we promised that we could make forty tank cars a month. I got a telegram from an administrator in Wilmington who was an assistant to the general manager at that time, who congratulated me on getting forty cars. In a talk I've given many a time, not enough people are willing to take risks. The two guys before me were conservative. I was willing to say that we could mobilize the organization to get what seemed to be unattainable. I think that probably helped me out. I don't really know.

BOHNING: Who did you report to when you became the Assistant Director?

MENDOLIA: I reported to Dr. Paul Austin. He was the Director of Research.

BOHNING: This was still within the Electrochemicals Department?

MENDOLIA: Yes, still in the Electrochemicals Department.

BOHNING: What kind of responsibilities did you have during those two years before you moved into sales?

MENDOLIA: Well, one of the things I learned a lot about was patents because the fellow who headed up patents reported to me. The Research Department at that time probably had two or three hundred people in it. About a third of them were operating pilot plants. I was responsible for that. The DuPont system in those days gave the Assistant Director practically all the day-to-day authority. It was a system for training guys, so you got a lot of responsibility that you wouldn't ordinarily get in other companies. As a matter of fact, I tried to convince the companies I was with subsequently to use the DuPont system and I failed miserably because they said it's too expensive. But it was a hell of a way of training people to do a job. I ran the staff meeting as the Assistant Director of Research, and the Director of Research just sat by. So you learned a lot, a hell of a lot.

BOHNING: You said that there was a high-level employee relations group that tracked the experience of the managers.

MENDOLIA: They did. As far as I know, they still do. That was an interesting project. You'd be interviewed about once a year about what you were going to do with these people who apparently were ready to move. Then these men would write that down and they'd come back to you in six months or a year later and say, "What have you done with so-and-so?" You tended not to move people that were doing well in their job. You hated like hell to move them into a job for which they were untrained, just to give them more experience. So it was very useful to have these guys come around and jibe you about the moves that you ought to make. It was a useful function of the DuPont Company. By the way, the employer-relations people had usually been plant managers. They knew all of the ins and outs. They knew why you didn't want to do it. They were very knowledgeable. So you know, in a low-key way, they'd urge you to take action. It worked.

BOHNING: Now, at this point, you're moving away from production, and you're moving away from research, in terms of being directly involved. Now you're becoming more of a manager. How did you feel about that?

MENDOLIA: Well, I was a researcher. I went into production, but really liked research. The way I learned to become a manager, was when I was in the ADN plant, I was Technical Superintendent, then Production Supervisor, and then back to Technical Superintendent. Well, when I went back to Technical Superintendent, I realized, "I gotta sell this guy on my ideas, and if I fail, he's going to do what he wants." That's when I decided that it was better to be a manager and worry about people problems than to be a technical guy. That was probably in 1951 or 1952, when I made up my mind that that was the real route for me, and that's when I ceased to be a technical guy.

BOHNING: Two years later, in 1956, you moved to the sales department, and this must have been quite a new experience for you.

MENDOLIA: Quite new! I knew nothing about sales. But again, the Electrochemicals at that time had a Director of Sales and two Assistant Directors, and I was one of two, and the guy that taught me a lot about sales was the other assistant. His name was Eddie McGovern, a graduate of Lehigh in 1929. I'll never forget the story he told me. He said it took him until 1937 to get back to his starting salary! There were two 10 percent cuts somewhere. [laughter] But he taught me a lot about sales at that point in time.

We had to write an annual report on sales, goals, and how we performed. Apparently the Assistant General Manager, finally the President of DuPont, a fellow named C. Brelsford McCoy, didn't like the report, so I got this job of rewriting the whole thing. It must have been accepted. I think the training I got years earlier from my boss who said, "Be bright, be brief, be off!" was useful. I wasn't in sales long enough to really learn much about it. I became Assistant General Manager because in 1958 DuPont decided to elevate the status of the Foreign Relations, which was an auxiliary department. The new head of it was Sam Carpenter, who was Assistant General Manager of El Chem. Sam was a son of Walter S. Carpenter, who'd been President of the company. He was yanked away. I don't think he'd been in El Chem for nine months. So the management had to figure out, "Who are we going to make Assistant General Manager?" I'm hoping that the reason that came about was probably because of my writing skills. But I don't know that.

BOHNING: What kinds of responsibilities did you have in the sales department?

MENDOLIA: In the sales department I was responsible for the technical end. This is an interesting process. About that time DuPont built what they called "Chestnut Run," which was

a sales research laboratory. We couldn't get anybody to go there because all the research chemists said, "God! That's the end of the road!" [laughter] It took maybe three or four or five years to really staff the organization with people who we thought would be good, because they said, "These programs are negligible." So the other Assistant Director of Sales had straight marketing. He had the district offices reporting to him. But again, he was a very influential guy in teaching me the ropes, because those lines were not as rigid. I got to know customers, I got to know the district managers, and we made a lot of calls together, because how do you learn a part of the business you know nothing about? One of the things I learned is that it's damned hard to predict what is going to happen in sales. That was quite different from R&D or from manufacturing where you were dealing with more finite extrapolations. To this day, I don't believe sales forecasts because basically you're trying to predict what your customer is going to do, and he doesn't know what he's going to do, so how can he tell you what he's going to do? It's the most uncertain part of the industrial world. It was then and it still is today. I read the *Wall Street Journal* about every day and when somebody says, "I'm going to forecast what I'm going to do next year," [laughter] I say, "I don't believe it!" [laughter]

BOHNING: You moved up then to the Assistant General Manager in 1958.

MENDOLIA: Yes.

BOHNING: Who were you reporting to then?

MENDOLIA: I was reporting to Don Notman. He was the guy who had been Plant Manager at Niagara Falls. He was a bright guy. He was a Queens Scholar in Canada. I think he went to Queens University. Bright, but not bright enough. When I was in Washington, I got a letter from Don Notman, who was retired, living in Tucson. He had been a smoker all his life, and his letter said to me, "I've got a cigarette dangling out of one side of my mouth and an oxygen tube out of the other," and he knew the implied danger. [laughter] Now he was one of the brightest guys I've known, but as you know, smoking was so addictive, he couldn't quit. He died a few months later.

BOHNING: What kind of responsibilities did you have then?

MENDOLIA: Well, again, I ran the staff meetings. I had total responsibility. This is the case where the General Manager sort of sat and watched you while you learned, and it's a tough process. As a matter of fact, I probably got as nervous and unsettled for a year or two because the learning process was intense. You had to learn at a great rate. I was forty-one years old. Practically all the guys who reported to me were a lot older than I was. So you're worried about being the youngest guy on the block and still telling these guys what to do. But it was an

interesting process. When Don Notman retired, he was succeeded by Dr. Jack Clark. I worked for him for about six or seven years. He was a Ph.D. chemist from Cornell [University]. His family had founded Clark Equipment Company in Michigan and he was a Director of Clark Equipment. He was also a trustee of Cornell. He maintained very close contacts with his university. He was a bright guy. He came out of the Photo Products department to become head of El Chem. He threw one of the best parties I have ever been to in Wilmington, or anywhere, for his 35th wedding anniversary, in the Gold Ballroom in the Hotel DuPont. Ever been to the Gold Ballroom in Wilmington?

BOHNING: No.

MENDOLIA: He had Victor Borge as one of the entertainers. He didn't want any toasts during the party. After the party he told his wife, "This is it. I'm getting a divorce." After thirty-five years of marriage! He came to me the following morning, because I was his assistant, [laughter] and said, "I just told my wife that this is the end of the road!" It also goes to show you how little you know about what going on in the office because the gal that he married was named Ruth, and that romance must have been going on for a few months, within twenty feet of us [laughter], and I knew nothing about it! But he married that gal, then divorced her, and married a doctor, and then he committed suicide. I don't know. He was a knowledgeable guy and smart as a whip. I learned a lot from Jack Clark. But the responsibility was running the department. The General Manager said his job was to see that you didn't make any mistakes.

BOHNING: You continued in that, looks like about eight years.

MENDOLIA: Yes, I did. Well, I've learned subsequently that Lammot du Pont Copeland, who was then the Chairman of the company, thought I was too young. There have only been three guys who made Assistant General Manager that were forty-one, and two of them became Chairman of the company: Brel McCoy was one, and Dick [Richard E.] Heckert was the other. The Chairman said, "This guy's too young!" [laughter] "What's he going to do next?" He was probably right.

BOHNING: You did make a change in 1966, then.

MENDOLIA: Yes, in 1966 I went to the Explosives Department, and I was the first non-Explosives person ever to become an assistant general manager. The reason was the Executive Committee, which we had in those days, felt that the Explosives Department was wrong in a lot of different directions and they figured the only guy who could change it is some new manager that would look at it freshly. I was told that Explosives was going to have its first sales meeting at the Broadmoor Hotel in Colorado Springs, about a week or two before I officially came

aboard. So I went out to the meeting to meet all the salesmen. I sat in on a technical session. There was some guy talking about ANFO. I put up my hand and I said, "What is ANFO?" I never got an answer because ANFO was Ammonium Nitrate Fuel Oil mixture, which had taken 85 percent of the dynamite business [laughter] in the previous ten years. They figured, "This guy is going to be our boss?" [laughter] I've never forgotten that story. [laughter]

BOHNING: That's a great introduction to your new group! [laughter]

MENDOLIA: Oh, gosh! [laughter] But you know, that was an interesting job because the Explosives Department made two textile-fibers intermediates. We made acrylonitrile by a DuPont process. It was terrible. It was way behind the power curve. So I had to go hat in hand to Sohio, who owned the process for making acrylonitrile, and get a license. That was tough job. We also had a process for making dimethyl terephthalate using nitric acid for the oxidation of para-xylene, and that stunk. We used to blow up a condenser that was about 30 feet tall, about once a month. Here these men were experts on nitric acid oxidation but they couldn't stop the explosions. Fortunately they shrouded the condenser so that when it blew up, [laughter] it didn't kill anybody. This is how, in some respects, I got acquainted with Ralph Landau, because he tried to sell his technology for making terephthalic acid. He couldn't sell it to DuPont, who should have bought it. Couldn't sell it to ICI who said, "We're about to invent the process." So he sold the whole thing, lock, stock and barrel, to Amoco [Chemical Company]. So I had to go to Amoco, hat in hand, to get a license to build our process, and they wouldn't give me a license. Well, finally, we got a license by agreeing to buy a lot of dimethyl terephthalate for probably five or six or seven years. Then they agreed and gave us a license. But that was hard to do. If you were an insider, you would have had a tough time doing that because you would have had the whole organization against you, believing that you're going to bring new technology in. We did one other thing that was unusual in DuPont in those days. We got Badger Construction to build the acrylonitrile plant because they had built maybe fifteen of them around the world. They knew how to do it. The Engineering Department, which was a powerful organization in those days, finally succumbed but it took some real doing to get Badger to build that plant—which they did. Safety was preeminent. It started up like a charm. It was a good operation.

BOHNING: There are a couple of things I'm curious about. One is, why are these intermediates being made within something called the "Explosives Department"? Or is there a historical reason?

MENDOLIA: It is historical, yes. In other words, DuPont had a lot of internal competition for a long time. Probably up until maybe ten years ago, there was a lot of competition, so you followed the inventions, no matter where the inventions were made. By the way, DuPont rarely turned down a project. Profits were so high that the Executive Committee practically said yes to almost everything. There was no serious attempt to set priorities in the company until maybe

ten years ago. So the net result is, intermediates could show up anywhere. It all depended on where the invention was made, or who got a license to a process. So Explosives and El Chem made acrylonitrile. We had a plant in Memphis, Tennessee, that made it from acetylene and HCN produced by El Chem. Acrylonitrile made by the new route produced HCN as a by-product, which was sort of interesting because we were not the only producers of acrylonitrile via the Sohio process, and HCN was a co-product. We were the only ones who would sell HCN in tank cars. Monsanto [Company] made it, American Cyanamid [Company] made it. They were worried about shipping HCN by tank car, and as far as I know, to this day DuPont is still shipping HCN by tank car. But those tank cars were ruggedly built. You could turn them upside down, you could crush them. They wouldn't rupture, because the walls were extraordinarily thick. We only had one incident where there was a rupture disk made of lead, and apparently there was a fire, timber or something, and the disk melted. But as you know, HCN will burn, so nobody was hurt or killed. Now most of the HCN production is adjacent to the consuming plant. I don't know whether HCN is being shipped by rail anymore.

BOHNING: Another question I had was about the reluctance that you experienced to new technology. Was that an isolated occurrence within DuPont, or do you think it was a common occurrence in DuPont?

MENDOLIA: Well, what do you mean by that question?

BOHNING: Well, you had to go out and get new technology because the old processes were outdated.

MENDOLIA: Oh, well, that's what I'd call—you've heard this before—the NIH [not invented here] factor! [laughter] As a matter of fact, that's why Ralph Landau had to sell his technology, which he had developed, because ICI thought they were right on the verge of developing the technology. DuPont probably thought it had a better process. Ralph Landau's researchers ran it on a laboratory scale. So somebody had to spend a lot of money to develop the process. Here's where the NIH factor comes into play. Probably more often than it ever should.

[END OF TAPE, SIDE 3]

MENDOLIA: To me that's a serious problem, was and still is. Everybody thinks what they've got is better than what is being proposed. As a matter of fact, when I was in research in DuPont, we had a tough time accepting new ideas from outsiders because you never knew where in the DuPont Company somebody else had a similar idea. Then you'd have a confluence of an outsider's ideas, and then if you got a patent on it, God, the outsider would sue you. So we

probably passed up a lot of good opportunities because we were worried about what eventually could lead to a suit.

BOHNING: Now, you went outside for two different processes. Were you given those marching orders, or was that your decision?

MENDOLIA: No, they weren't my marching orders. But the DuPont acrylonitrile process was a low-yield process. I knew in El Chem that there were better processes for making acrylonitrile, and it didn't take long to get an evaluation of the yield from propylene. So that was an internal selling job, which, by the way, as I recall, was not very easy because you had an entrenched group that liked what the hell they had. Although, you know, it's funny. I can recall seeing the acrylonitrile plant that Explosives had and it was an atypical plant. The equipment was crowded together, you'd have a hell of a time doing maintenance, and I wondered, why was that so? Well, probably because they were trying to keep the capital cost down, and they put the equipment closer together than they should. That said to me, there's an internal problem with that. There were at least fifteen Sohio acrylonitrile plants around the world. The terephthalic acid process, that was a little tougher haul. Why? Because the Textile Fibers Department didn't want to switch to terephthalic acid, which was what was made by Amoco. They wanted to use dimethyl terephthalate, and I hate to think of how much time I spent with the Textile Fibers Department saying, "Why don't you use it?" They came up with a million reasons why they couldn't, and it took them ten or twelve years before they switched to terephthalic acid. They said it doesn't dye right. Well, it's pretty hard to contradict the experts in the field. Terephthalic acid is cheaper than dimethyl terephthalate, but if you're making a lot of money on polyester, so what? Today I think DuPont is still the world's largest polyester producer. I'm not sure of that. So it's tough. You've got to be a hard salesman—a persistent, persuasive person, and it also doesn't hurt to be at the top. [laughter]

BOHNING: Whom did you have to sell first?

MENDOLIA: I had to sell the production people, and that was tough to do. It took a long time. It took months. It had to take months even to make the first visit because the men that you had to bring along were guys who were opposed to the idea to begin with. So it took a lot of persuasion and salesmanship to get these fellows to agree to at least evaluate another process. Just to take a serious look at it. You know, I've been out of DuPont for twenty-five years [laughter], so my memory is not as good for some of those details.

BOHNING: Was this something relatively new in DuPont, going for outside technology, or had people done it before you?

MENDOLIA: Well, yes and no. In the 1920s, DuPont had a lot of money from World War I and they bought up lots of companies. As a matter of fact, I made a speculation that one of the reasons Wallace H. Carothers was as successful as he apparently was in inventing nylon was that DuPont bought rayon from the French and they bought a film manufacturer, and chemists who were on Carothers' original team, like Julian Hill, Gus Dorough, and others, knew those businesses. So when the technician said, "Look at this stuff I've got," and pulled it, they were people who had experience to envision what could be done with that product. I speculate that if that weren't true, in other words, if Carothers had invented it, it's hard to say whether that invention would have been recognized. So, yes, DuPont did a lot of buying in the 1920s. DuPont bought lots of interesting properties. It bought a pigments department. It bought a route that was different. The sulfate route was the next one they used, and the managers who had the technology had an opportunity to buy the sulfate route but they chose not to buy it because they said it's not as good as what we've got. And National Lead [NL] Industries bought that technology, and I hate to think how much money they made. That's a classic example of the NIH factor. One of the questions I was asked many times after I left Halcon was, "Why was R&D so successful compared to other companies?" I said, "It was a relatively small outfit and I sat in on many a staff meeting where the R&D people sat in on the same meeting with Ralph and the other people that were there, and so if the decision went against the R&D, all the guys in the R&D heard all of the arguments. It wasn't relayed to them through three or four layers of supervision. That made a lot of difference. I know in DuPont, if the general management didn't like an R&D project, it might be three or four or five levels down, and who's to say what kind of story they told? It would be tough. So that's an important element in R&D, the closeness between the management, the decision-making process, and the R&D. The further the separation, the less likely it is to be successful.

I made a point that DuPont was one of the first companies to put R&D facilities in Switzerland. It was a total failure. Why? Because the Geneva R&D organization had a lot of bright chemists but were a long way from the people that were going to implement the ideas. There was no good communication. Now, that would not be true today because of e-mail and networking. But the speaker from Exxon made the same point that the R&D today is more closely aligned with the commercial objectives. Now, that may be bad. Dr. Boffa said basic research is still largely done by universities rather than industrial companies. That's probably true up to a point, and there has been probably a shifting away to commercial objectives. The pendulum swings back and forth.

BOHNING: So you learned how to be a good sales person during this time period, selling new ideas?

MENDOLIA: Well, I think so. I think to be a good manager, eventually you have to be a good salesman with your own organization. If you're not, you're not going to get very far.

BOHNING: In 1970 you were moved up to Vice President.

MENDOLIA: Yes. DuPont had few titles. We used to compare ourselves with other chemical companies, and the general manager headed up a big business. I guess some people said, "Why shouldn't he also be a general manager and vice president?" So that was changed. That's in contrast with Union Carbide [Corporation] where, somewhere about ten years earlier, some of the management got enamored with theory Y and theory X, and God, they had titles galore. A guy was president of production, and that was one extreme. DuPont was at the other extreme. I think it tried to ameliorate that discrepancy somewhere around 1970. So we were general managers and vice presidents, and the job stayed the same.

I went to Africa this year. In 1970 I had planned to go to Africa on safari, and the president of the company was Ed Kane. He called me up, and said, "You'd better not take your trip because we're going to reorganize DuPont, and you'd better stay home and protect your fanny!" [laughter] That's when Explosives was changed to the Polymer Intermediates Department. There were shifts made in businesses from one department to another.

BOHNING: You maintained that position when the reorganization took place?

MENDOLIA: Yes. I did.

BOHNING: It was probably a good time for DuPont to get rid of the word "explosives", too.

MENDOLIA: Well, I've got to tell you a story about that. I sold the last black powder plant that DuPont had in the United States, and where was it? It was at the end of the Scranton-Wilkes Barre airport. I forget what the name of the town was. I said, "What the hell? What if one of those Allegheny Airlines planes comes in just when you had an explosion!" So we sold that last plant. But it's interesting. The U.S. Army was still the biggest consumer of black powder in the United States, but it takes about two years before the Army could get money. They said, "Lookit! We can't buy it but we want it. You find somebody that'll buy it, we'll give them a contract for five years." That's the way it was finally done. I don't know runs it now or whether it's still running.

BOHNING: When I lived in Wilkes Barre, I lived maybe twenty miles from the airport and every once in a while we'd hear an explosion! [laughter]

MENDOLIA: You're kidding!

BOHNING: I remember them clearly! They wouldn't even let the State Police on the company grounds. The reporters would show up and everything was barred at the plant gates because it was buried back in the mountains.

MENDOLIA: Yes, way back. Well, you know, most DuPont explosive sites are big. They're usually 3000 to 4000 acres. One reason is, you've got to store the stuff and they're stored in bunkers, and those bunkers have to be so-many-thousand-feet apart, because you can propagate an explosion from one to the next, so the sites are big. As a matter of fact, Cy Baldwin and I almost bought a plant from Rhone-Poulenc. It was in Pennsylvania someplace. It was an old dynamite site, but the ground had lots of nitroglycerin [NG] in it. NG lasts forever underground. We didn't buy it. There was a formaldehyde plant on the site, which is what we wanted, but it was in the middle of other chemical production. We finally walked away from it. But it was a reminder that explosive sites are dangerous and they stay sitting there forever.

BOHNING: A lot of the black powder existed in that area up there because of the coal mines.

MENDOLIA: I know that. [laughter] One of the guys that I got to know too well from Wilkes Barre was Dan Flood. Did you know him?

BOHNING: Yes, sure.

MENDOLIA: When I was in the Pentagon, somebody said, "We can't buy any grates for the hard coal furnaces." The American troops were freezing in their barracks because you couldn't get any spare parts. I said, "Well, let's buy some Polish coal." Well, Dan Flood heard about it. I got a reaming. [laughter] He called me into his office. I heard about him being an actor, but he had this ruffled shirt on and an affected manner. [laughter]

I've got to tell you, I thought aid to the troops was Democratic. But Senator John Heinz approved the same law about ten years later. He was subsequently killed in a plane crash. It proved that the action was neither Democratic nor Republican. It was people reacting to the needs of the constituency in that area. I don't know how much hard coal is really produced in that area.

BOHNING: There's some strip mining going on, but there are no deep mines at all. They're all closed. But we used to smile at the fact that we were shipping coal from Wilkes Barre all the way to Germany to heat Army barracks! [laughter]

MENDOLIA: Probably still going on! [laughter]

BOHNING: Dan Flood was a very important person.

MENDOLIA: He must have brought a lot to Wilkes Barre. He must have been Congressman there for a long time

BOHNING: Forty years.

MENDOLIA: Then he got nailed for something. I forget what it was.

BOHNING: I don't know what it was, either. But there's a Veterans Administration Hospital there; the Social Security Administration office controls the paychecks for everywhere east of the Mississippi, out of Wilkes Barre. Yes, he did very well by the area. But he was very powerful. He was head of the House Committee on Defense for a long time and that's probably where you ran afoul of him. [laughter]

MENDOLIA: You know, I raised hell with my aides because a couple of times I got into problems with very powerful Congressmen who thought that I was trying to screw them up. I said to my aides, "Tell me who these guys are!" [laughter] I tried to shut down a cannon works in Troy, New York, where Rensselaer [Polytechnic Institute] is, and they'd been making cannons there for a hundred fifty years. The government wasn't supposed to make cannons. There was a presidential edict or a law that said that had to be privatized. But they were still making cannons. So I tried to shut it down. Well, then I found out that the Congressman from Troy was a very powerful person. God! Don't get in his way! [laughter]

BOHNING: You've already started talking about your DOD [Department of Defense] experience, but let's go back to DuPont. Up until that point, after the reorganization, did anything else change? Did you have any other big projects that you accomplished?

MENDOLIA: No, but that's how I got acquainted with Ralph Landau. Ralph Landau came to me somewhere around 1972. He had developed a process for making ethylene glycol, and DuPont was the logical buyer because it was a key raw material for making polyester fiber. I guess my view and the view of our people was that it was a meritorious process. In January of 1973 or February of 1973 I was asked to join the government. I said to Ralph, "We'll make this deal." Ralph wanted to have DuPont buy the ethylene, which was the raw material. Well, in 1973 we had the first oil crisis, and in 1973 DuPont couldn't get a long-term contract for ethylene, so that's when Ralph turned to Atlantic Richfield and they put up a couple hundred

million dollars to build this plant. That's how I got to know Ralph. I knew him before that, but not well. We spent a lot of time together, and that's how I got to work for Halcon, because he gave me a call when I'd already left the Pentagon. He said, "How would you like to have lunch at Lutece?" Well, who's going to pass up lunch at Lutece, right? And he offered me the presidency of his company and I turned it down because I said, "I'm going back to DuPont." I'd rented a house in Centerville, Delaware. Within a week or two, and this shows you how fate plays a part in your life—his partner died, whom I'd never met; a guy named Harry Rehnberg. He died and the directors said to Ralph, "God, you've got to find some warm body." [laughter] So he came after me with a deal I couldn't turn down. That's why I didn't go back to DuPont and why I went with Halcon.

BOHNING: I have a couple questions about your government experience. First of all, who asked you at DuPont and why?

MENDOLIA: Bill [William] Clements was the Deputy Secretary of Defense in 1973. He was Eliot Richardson's deputy. He had founded a company called Sedco Corp., which was an oil field drilling and service company. He was a guy with very strong opinions. He said, "Why the hell don't we get assistant secretaries who know something about the business world, rather than guys who help elect a president?" So he persuaded a couple of investment bankers in Texas to do some recruiting. They must have called, I don't know, twenty-five or fifty companies. At DuPont they called Brelsford McCoy, who was then chairman of the company. Apparently the executive committee thought about that for a long time, about even submitting a candidate. I don't know whether you recall this, but in World War I we were considered the merchants of death. DuPont constructed the Hanford plant in World War II, and we got out of that as fast as we could. So there was a lot of debate in the executive committee about even submiting a name. Finally they said, "Yeah, let's do that." So I got a call from Brel McCoy and he said, "How would you like to go to Washington?" I said, "That's the last thing in the world I'd want to do. Why me?" Well, I was responsible for the tritium plant at the Savannah River Works, and Explosives had a fair number of defense contracts. He said, "Hell, at least you know the jargon." So, after some thought, I said, "At least I'll go down and talk to Eliot Richardson and see what it's all about." By the way, Richardson was very persuasive. [laughter] He said, "You ought to do something for your country!" At that point in time, I saw the likelihood of me advancing in DuPont, and I said, "At fifty-six, that would be an interesting change." I didn't realize this, but this was during the Watergate days and men were leaving the White House at a great rate. One of the questionnaires I've still got in my file is from John Dean III, which was twenty-nine questions—twenty-eight very specific, and the twenty-ninth says, "If you haven't written down what may be embarrassing to the [President Richard M.] Nixon administration, please do it now." Well, he was out before I got a chance to send him that questionnaire back. [laughter] So that's how I got involved. That wasn't my intention. DuPont floated my name before the Defense Department. As a matter of fact, I'll never forget, I was sitting in Eliot Richardson's office one day. He said, "Well, I haven't heard whether you've accepted our offer yet." I said, "I haven't been made an offer." [laughter] Which is the way the Pentagon is organized.

When I first got there, I said in typical DuPont fashion, "I want an organization chart." My aide said, "We've got a million civilians, and two million military men. What organization chart do you want?" [laughter] In the Pentagon there are twenty-seven thousand people! I was there a couple years. I don't think I ever visited all the parts of the Pentagon organization. It took a long time to get through the approval process, because the White House staff that had to approve Presidential appointees were all out on their ear. So it took about two or three months. I'd be going down to Washington not knowing whether I had a DuPont job or a Washington job. As a matter of fact, Jim [James] Schlesinger was made Secretary of Defense when Eliot Richardson became Attorney General. The only time I ever went into the CIA [Central Intelligence Agency] was when there were three or four of us that had not been approved by the Senate Armed Services Committee. We were asked to come down to the CIA and interview with Jim Schlesinger, so we went up. The only time I've ever been there. [laughter] Schlesinger was extremely bright, but a terrible administrator. The number-two guy really ran the administrative end of the Defense Department.

BOHNING: You were an Assistant Secretary of Defense. How many assistant secretaries were there?

MENDOLIA: At that time there were eleven. But there were four that were more important than the other seven, and I was one of the four. Even though I'd come from a large company, one of the things that just appalled me was we used to meet in what was called a DSARC. Don't ask me what DSARC stands for because I can't remember. But we used to meet once a week on approving military projects, which varied anywhere from a billion dollars to five billion dollars, somewhere in that range. The committee was composed of the Assistant Secretary of Research and Development, the Comptroller, the Assistant Secretary of Analysis and Evaluation, and me. You'd get briefings and you'd approve a project that was, say, a billion dollars to five billion dollars, and most of the time I didn't understand the presentation because the acronyms were so horrendous! [laughter] But it gave you some feeling for the magnitude of the Defense Department. At one of these sessions, there was a young guy, probably about twenty-five or twenty-six years old, and he said, "We ought to spend a little money on this project." I said, "What do you mean by 'a little money'?" He said, "Fifty million dollars." Well, at DuPont fifty million dollars was a lot of money, but the R&D budget in the Pentagon at that time was sixteen billion dollars. It's about thirty-five billion now. So it gave you some feeling for scale.

[END OF TAPE, SIDE 4]

BOHNING: What was your situation at DuPont when you went to Washington? Was your job still open there or did you have to resign?

MENDOLIA: It couldn't be. I had to resign. As a matter of fact, one of the more complicated aspects of life was that I had DuPont stock and DuPont "dividend units," which I was asked to sell. By the way, the fellow who asked me to get rid of them eventually became the head of the CIA. He was a young lawyer for the Armed Services Committee named Jim Woolsey and the reason he wanted me to get rid of the DuPont stock and the "dividend units," which is like phantom DuPont stock, is another chemical administrator, Kenneth Rush from Union Carbide, had come into the government. I think he was in the State Department at the time, Assistant Secretary or Deputy Secretary. The Armed Services Committee hadn't done anything about these dividend units that he had from Carbide, and he was getting money from that. So they wanted Kenneth Rush and me to get rid of them. Well, DuPont gave me a low-ball price. Why? Because DuPont dividend units were in a person's estate and they try to keep that low. So DuPont finally solved all the problems by getting a guarantee from J. P. Morgan that if the DuPont dividend went down, I would get a check from J. P. Morgan for the difference between the old dividend and the new dividend. Believe it or not, in 1974 the DuPont dividend went down, and I got a check from J. P. Morgan! [laughter]

But it's sort of interesting—the gyrations that the government goes through to keep everything clean. In 1973 there was an oil crisis, and I was the top guy in the Pentagon for oil and energy. Why was it? Because Bill Clements was the Deputy Secretary and knew everybody in the oil business because he had an oil field drilling and services company. He was not permitted to be the representative because he knew too much about the oil business. He was involved. He still owned Sedco stock. So as a result I attended many cabinet meetings that I shouldn't have any more been in than the man in the moon. This example shows the perverse nature of the Washington environment.

We didn't know where fuel was consumed in the Defense Department. I called up a few of my friends in the business. I called up Exxon. I knew the president of Exxon Chemical, and I said, "I need a guy that really knows transportation and movement of oil very well." He sent me a guy from somewhere in Texas. The guy came up to Washington and after he'd been there about a month, Jim Schlesinger said, "You got to get rid of this guy." I said, "I can't get rid of this guy. He's moved his family up." But that was because the press was homing in on people that were knowledgeable. If they came out of Exxon or DuPont, you had to discharge them. We had to find him another job. I forget where he went. He stayed in Washington, but he was not in the oil and energy business of the government.

I'll tell you one other story about not knowing anything. We didn't know where the fuel went in the Defense Department because it was so cheap up until that time. I was given the job of putting together a system. I said, "Gee, how am I going to do that?" Well, there was a fellow named Admiral Sonnenshein who had been head of naval shipbuilding, and he got canned from that job because he used to agree, by a handshake, the overruns on a carrier. Carriers take about twelve years to build. The Congress didn't like that. If you've ever tried to figure out who's responsible for change, it's damned hard to do. But he got canned. So somebody said, "Get Admiral Sonnenshein." Well, I offered him the job, which was to find out where the hell we used fuel in the Defense Department. He put together five hundred or six hundred people,

which he got quickly, and in about three months we had a system that told us where the fuel was being consumed. It was interesting because my job was to give a report at the weekly staff meetings attended by the Joint Chiefs of Staff. I was showing the Joint Chiefs that the fuel consumption was going down. They said, "You're going to destroy our readiness!" I said, "Look it! The readiness is still where your guys say it was."

I have to tell you one other thing. The Congress was very unhappy with the comptrollers of the services because they would overrun their budgets. They passed a law that said if a comptroller overran his budget he could go to jail. It takes roughly two years to get money from the Congress. There was one other factor I can't remember. But the facts are that we didn't know where the fuel went. Well, we found out and it was interesting. People were ingenious in the military. So a pilot, instead of taking a one hundred fifty-mile run to a bombing target, did it in fifty miles. Fuel consumption went down and readiness stayed about the same. The fuel consumption was up, but it went down a lot. Knowledgeable managers said it should have gone down. At least we finally knew where the stuff was going. [laughter]

BOHNING: Whom did you report to directly?

MENDOLIA: In the Pentagon? I reported to Bill Clements, the Deputy Secretary of Defense.

BOHNING: Oh, you did?

MENDOLIA: Yes. He managed the Pentagon. Schlesinger was as bright a guy as I've known, but he concerned himself with the relationships to the Congress and the White House. He was damned good at that. So I saw a lot of Schlesinger but mostly when it had to do with testifying before the Congress. One day he called me agent provocateur. I had to look it up. I said, "What the hell does he mean by that?" He probably meant that I was being obstreperous with the Congress. [laughter]

BOHNING: Like upsetting Dan Flood. [laugher]

MENDOLIA: Exactly right!

BOHNING: Of course, you ran into the old acronym problem again.

MENDOLIA: That was a big problem. You know, I asked a lot of people if there was a dictionary of acronyms somewhere. I'd say in about six or nine months I finally found a

Defense contractor who had put one together. The book was about 2 inches thick, you know! [laughter] You know, the thing that's interesting is that acronyms have become words. The few times where I interrupted a presentation to say "What does that acronym mean," the guy didn't know what it meant! [laughter] I've got to tell you one story about acronyms. Even in DuPont, when I moved from the El Chem to Explosives, AN was Acrylonitrile. In Explosives acrylonitrile was ACN and AN was Ammonium nitrate. So if you think a man doesn't get confused! That's why I didn't know what ANFO stood for. I said, "What hell does ANFO mean?" Acronyms are tough. But they're everywhere, as you know better than I do.

BOHNING: You have said that you had to change your management style to cope with the magnitude of the assignment.

MENDOLIA: Well, you know, I was asked several times, "How did you manage your job in the Pentagon?" I said, "By doing only the things that I thought I could make a change in or help." While I have no way of estimating that, I would say I probably worried about 1 percent, maybe 2 percent of the job. My office had a staff of two hundred and twenty-five people who would answer the mail. The mail was enormous. Every night I'd get my aide, who was a Lieutenant Colonel in the Marines and we'd spend an hour just signing mail. I said to him, "I don't know what the hell I'm signing here. You're explaining it to me." But you had to sign it every day and I'm lucky that I didn't get nailed for something that I signed. Anybody could have said, "You signed that." Right? But the stack was about 2 feet high, every day. So, yes, I had to change my style because there's no way in God's green earth that I could cope with it. I became a people person. I've got some interesting documentation that I got from some of the services that I concentrated on the people that made changes in the Defense Department, or were in a position to make changes whether they wanted to make them or not. By the way, change in the Defense Department was very tough to do. The Deputy Secretary of Defense before me was David Packard of Hewlett-Packard [Company]. He recognized early on that these big defense projects were managed usually by a Brigadier General or a Colonel who had never had any experience in managing a project. Their tour of duty was usually about year and a half. He said, "We've got to keep these men in the job for at least five years, and we've got to develop a college to train a man how to become a project manager." The college was established in Fort Belvoir. Not the Industrial College of the Armed Forces. Well, I was involved. I went to Washington about ten or twelve years after I left there and I talked to the head of the Industrial College. I said, "Are you men still doing what Dave Packard said?" No, they weren't. Which taught you a lot about the ability to make changes, and would the changes persist after you've made them. If the military or the civilians don't like what you've done, they'll just wait you out. The average tenure of a presidential appointee is about eighteen or nineteen months, and those guys know that. So it's the rare person like Bob [Robert] Rubin, Secretary of the Treasury, who stays four years—very rare. So it's tough to make changes that the organization doesn't like because they'll just wait you out, and the changes that they do like, they'll make them, but they're few and far between.

One of the things that I learned in the Pentagon was that a military guy is trained to take orders. "Yes, sir." As a matter of fact, the Lieutenant Colonel who was my aide the first half of the time I was there, would still call me Mr. Secretary. I said, "Christ Almighty! Call me Art." Well, he couldn't call me Art. He wasn't trained. So we were trying to train project managers to deal with maybe a thousand subcontractors on a Defense contract, who didn't report to the project manager. They had a hell of a time understanding how you control somebody that didn't report to you, right? Because, again, in the military, everybody does! And should! The military does work that way. So whether that succeeded or failed, I really don't know. Well, it probably failed because you can't get a person to compartmentalize their brain. One part is for the military and one part is for a defense contract, and they don't have men who stay five years because that screwed up the promotion process. They're all on computers, and you had to move a man around a lot.

The other impression I got was some of the brightest guys I've ever known were in the military. They were well-educated guys. Since I'd never served in the military, I didn't know too many military men. But it's amazing how many of them had Ph.D.'s, because in the absence of war, in the post-war era, a lot of these guys got Ph.D.'s from Harvard [University], Yale [University], MIT, or Penn [University of Pennsylvania], or what-have-you. Well-educated, bright men, and a few of them came in to me and said, "I'm leaving." I said, "Why are you leaving?" He was forty-eight years old. He had thirty years in the Air Force, and the Air Force had a rule that if you weren't going to get promoted—out! So these fellows at forty-eight had thirty years service, which started the year they joined whatever academy, and at forty-eight they'd retire. A lot of them got good jobs because they were very good managers. The Air Force was number one, the Navy was number two, and the Army was number three in that regard from my observation. But it's a totally different environment, and it's going to stay that way for quite a while.

BOHNING: I listed here five unique aspects of the DOD that you've observed. One we've already talked about—the revolving door management problem.

MENDOLIA: Yes, it's terrible.

BOHNING: The second is the vast amounts of money, which we've talked about.

MENDOLIA: Yes.

BOHNING: The third is control by Congress. You've given me some examples of that.

MENDOLIA: [laughter] Totally controlled by Congress. [laughter] I went to a party for [F. Edward] Eddie Hebert, Chairman of the House Armed Services Committee, from Louisiana. This was after the young Turks in the Congress had decided that seniority wasn't important, so this gentleman was deposed. We went to a party for Hebert after he had been deposed. This guy was getting drunker than a hoot owl. A Congressman, Jack Kemp, got up to give a speech. There were about thirty-five or forty attendees. Everybody, including wives who'd probably never given a speech in their life, felt constrained to say something nice about Eddie Hebert. [laughter] Those changes don't occur very often in Congress. By the way, I think one of the reasons that we had such large increases in debt in the United States was that the key committee chairmen had a lot of control over their committees. They could deliver the goods to the executive branch of the administration. Once that was destroyed, there was nobody, basically, that could deliver the vote, and the net result is, we spent money we didn't have. We printed money for thirty years or thereabouts. At least that's my opinion.

BOHNING: Another unique aspect was the many constituencies you had to serve.

MENDOLIA: Yes.

BOHNING: The last one that intrigued me was the lack of loyalty by some staff members.

MENDOLIA: Well, we try to save money in the Pentagon. I'll never forget the time when I think we wanted to spend a small amount of money, and I mean ten thousand dollars or something like that, to find out whether we could get a third-party contractor to do the cleaning of Fort Ord in California. Well, somebody on our staff leaked that to the Congressman from that District, and the Congressman wrote about a two line item that said the Defense Department can't spend any money to get an estimate. That is what I meant. You had to know who you were affecting, because the Congress very easily could cut off what they don't like, or what they think adversely affects their district.

One of the things that I've never forgotten, because it's important, is shutting down a military base. When I was in the Pentagon, we tried to shut down the Philadelphia Naval Base. They had so many powerful friends that they kept it off until I think about 1997 or 1998. It's damned tough. We shut down the Boston Navy Yard. Eliot Richardson, when he knew he was going to be Attorney General, signed the documents and left the rest of us with the problems of dealing with shutting down the base in Quonset Point, Rhode Island, and the Boston Navy Base. The Congress today has a committee that approves shutting down a military base. Now, the point I was trying to make—the group that reported to me was a group that figured out how to reuse old military bases. For instance, the Philadelphia Navy Yard will be given to the City of Philadelphia or somebody else for one dollar! Everything on it for one dollar! They'll be given a team of people that know a lot about bringing taxable industries—just like the shipbuilder—to that site and eventually they'll have a taxable base. Now, it takes time. But God! The

Congressmen moan about the jobs that are lost, and basically it isn't true. There are a lot of success stories, but the press hates to write about the success stories because you don't report good news. [laughter] You report bad news. Reporters think the job loss is more important than the eventual improvement. But there are lots of classic examples of military bases that have been shut down, and now bring a lot of revenue in because you've got taxable people there, not non-taxable.

BOHNING: In many big cities, they sit on ideal property, very exclusive property!

MENDOLIA: They've got some incredible property in the City of San Francisco. For years, we have been trying to get them to get rid of it. They don't want to get rid of it. As a matter of fact, one I'll never forget because a good DuPont friend of mine retired to the Island of Maui and apparently there was an article in the paper there. We were going to put air-conditioning in the housing on the cavity of Diamond Head on the main island of Hawaii. There's no breeze in there, so we were going to put in air-conditioning. I got this nasty letter from this retired DuPont friend saying, "What the hell are you doing putting air-conditioning in Hawaii?" Right? [laughter] But the Army owned a lot of property on the main island of Oahu and they wanted to build a nineteen-story hotel for the military. We said, "You can't do that." They said, "The hell we can't. We're going to use the money from the bar and the Coke machines, et cetera, to finance this building," and that building got built! [laughter] It's still sitting right near the Waikiki Hotel. A beautiful piece of property that should have been sold. But it's interesting, the military gets large amounts of money not authorized by the Congress, from Coke machines and bar income, and several other forms. Many millions. Well, I don't know how many people are in the military now, probably a million; there used to be two million. That's still a lot.

BOHNING: When you went to Defense, did you have a time frame as to how long you'd be there?

MENDOLIA: No. I think I thought I'd stay there during the whole Nixon administration, but again, Nixon didn't last very long, [laughter] and I worked for President Gerald Ford. Even though I was at a relatively high level at DuPont, I didn't have much of an estate, so I figured, "God, I've got to go back to work." I was fifty-six when I went to the Pentagon. I left when I was fifty-eight. So I figured I'd better go back and earn something for my kids and my wife. So I left earlier—not earlier than most presidential appointees, but you didn't have to make a commitment. I don't recall having made a commitment.

BOHNING: So your leaving was your choice.

MENDOLIA: Yes, it was my choice.

BOHNING: Did you have any interaction with Nixon or Ford? Did you ever have the chance to go that high up on the ladder?

MENDOLIA: Well, I'll tell you, I never kept count, but I sat in on many cabinet meetings that had to do with the energy crisis and other crises. Schlesinger sent me to many cabinet meetings that Deputy Secretary Clements couldn't attend. The Defense representative sits next to the President. The Treasury, I think, is on one side, and the Defense Department is on the other side. So I went to a lot of cabinet meetings. How many I went to, I really don't know. I almost stayed in the government because the energy office was established in probably late 1973, early 1974. Now, it's normal in the government that the Pentagon can staff these offices. The Energy Department now has about ten or twenty thousand people. At that time, they were looking for thirty-five, and I'll never forget, I got a call from Bill [William] Simon or his deputy, who later became the President of NYU [New York University], John Sawhill. He said, "When are you going to get us those guys?" [laughter] But we finally staffed all of the Energy office. The fellow that became head of the Energy Office after Sawhill and Simon left was a guy named Frank Zarb, who's now the head of the combined NASDAQ and the American Stock Exchange. I think he was with [Salomon] Smith Barney. Well, I was leaving the Pentagon. He wanted to know whether I'd be his Deputy Secretary of Energy. I said, "No, I've already decided to go back to DuPont." [laughter] But if "Potomac fever" had caught me, which I tried to avoid, I could have stayed, and I'd probably have been the head of Energy at some point in time, because as I say, you know damn well the guys wouldn't last very long. So, yes, I could have stayed, but I'm not a politician. That wouldn't have appealed to me in the long run at all. You had to do things that I don't think I'd have enjoyed, even though that experience was one of the most fascinating experiences of my life. I got to fly the F-14 and the F-15. I was on a carrier during night landings and day landings. I went down in a sub; I saw the Trident submarine. It was a hell of an interesting experience. But I wouldn't make it my career.

[END OF TAPE, SIDE 5]

BOHNING: Any impressions about Nixon and the cabinet meetings?

MENDOLIA: Nixon was a very sharp person, very astute. I never heard the four-letter words that were on tape. He behaved himself, well, as you'd expect a president to behave. So I didn't see the aspect of it, and Watergate, to me, never became as magical a subject. A fellow that I got to know pretty well in the Pentagon, Fred Buzhardt, was general counsel for the Pentagon. He became Nixon's lawyer during Watergate, and probably advised Nixon that nobody will have to give up the tapes. Well, he turned out to be wrong. The judge said Nixon had to give up the tapes. Nixon must have known that Buzhardt was a damned good lawyer. He became Nixon's personal lawyer on the Watergate matters. Nice guy. But it goes to show you how

difficult it is to predict what's going to happen. I don't know whether LBJ [Lyndon Baines Johnson] or JFK [John Fitzgerald Kennedy] had tapes. I don't know that. But that's what did him in. That's still being uncovered—what he said on tape. He struck me as a knowledgeable guy. I didn't have that much one-to-one relationship with Nixon.

I had more with Ford. For instance, with Ford, we tried to open up Elk Hills Petroleum Reserve in California. They were oil reserves that had been preserved since World War I, and we said, "What are we doing preserving it? Why don't we open it up?" I had a chance to sit with Ford on that job. Normally when you sit with a President, he has about a half a dozen aides and specialists. He didn't have any, and he was a very knowledgeable guy. But you know, the press pictures him as bumbling, who stumbles over everything. They keep forgetting that he was third or fourth in his class in law school. [laughter] But the image is still there. He was a sharp person, and he was willing to make decisions and do it without a lot of staff. I met maybe a half a dozen times with Ford under those circumstances. He finally agreed that we ought to open up Elks Hills, but it was a tough process. Why was it tough? Because there was only one oil company that was near Elk Hills. I think it was Chevron [Corporation]. So Congress worried that there's only one company that can take this oil out of there, and only one company that had an oil line, and they struggled with that for years. But finally it opened up. As a matter of fact, I noticed it was in the press probably in the last couple of months about increasing production there. Again, it's interesting the things the government does that make no sense whatsoever, which is to preserve that base. There were people waiting in lines in 1974. Not really waiting in lines because there was an oil shortage, but because of government action. They wouldn't spend the money to improve Elk Hills because there were only a few people who could do it. They wanted to put it up for bids. Well, there aren't that many companies in southern California. But it's tough. Those are the aspects of political life that's tough. You got to throw things open.

The reason the Defense Department or the government has such old equipment is because you've got to put it up for bid, and you've got to pick the lowest bidder, and the outfit that has the best equipment doesn't get a chance. As a matter of fact, I noticed on this John Glenn expedition that they said, "That craft up there has about ten laptop computers that were just bought off the shelf." They were. That's considered bad in the government, because you can buy stuff for a tenth the cost. When I looked at the specifications for a thing like a simple radio, the radio would cost a bundle. We tried twenty-five years ago to get the military services to buy stuff off the shelf. It probably took fifteen or twenty years for that idea to percolate through, and probably it only percolated through when they were getting truly cut back. But it's just too bad, because that's where the toilet seats cost six hundred dollars. You look at the specs for a toilet seat—God. There weren't too many people who were making those toilet seats. [laughter]

I've got to tell you one other story. When I was with DuPont, we sold explosive bolts to probably the Army or the Air Force. We sold them at fifty times what we sold explosive bolts to anybody else. I asked my guys, I said, "Why do we charge the military so much for the explosive bolts?" They said, "They want to destructively test 90 percent of the bolts to be sure they work." Well, when I first flew the F-14, one of the things I had to do was get trained. I

had to learn how to eject my seat. There were explosive bolts there, and I found out right then and there, "Now I know why you want to test those," because if they didn't work, you'd be sitting with that seat, the explosive bolts would destroy the seat, you'd pull a little lever and the seat would disappear. [laughter] So there's method in the madness there someplace.

BOHNING: When you made the decision to leave, did you first call DuPont to see if you could come back to DuPont before you hooked up with Ralph Landau?

MENDOLIA: Well, I got to tell you a little story about that. You can't do that. First I had to show up at DuPont, then I went to see Irving Shapiro, who was then the CEO, and said, "I'm back. Have you got a job open for me?" Well, it's just like coming back from Japan. DuPont doesn't have a job open for me. They started thinking about it. But in about a week, he said, "Yes, we have got a job. We've got a man retiring. He's head of the International Department. How would you like that?" I said, "That would be terrific." I had about two months before this Ben Schlimme would retire. In the meantime, Ralph Landau is coming in with this offer.

Then, as I recall the story, the man who wanted to retire wanted to get the announcement out in the next three or four days. This is while I'm negotiating with Ralph and telling him I'm going back to DuPont. So I had to make a decision with nowhere near enough information on whether I should stay with DuPont or go with Ralph Landau. I decided to go with Ralph Landau, but I didn't have the deal reduced to writing. Indeed, the lawyer who was negotiating my contract was a Princeton man named Joe [Joseph] Batchelder [III]. He's become relatively famous negotiating contracts for departing or incoming executives. When I joined Halcon, Landau told me within the first month that he had told his lawyers, "If the proverbial truck knocks me off, here's what I've agreed." [laughter] It was a good agreement but I didn't know that, so I had to make a decision with nowhere near enough preparation. But I wasn't going to go back to DuPont, I was going to join Ralph Landau in New York.

BOHNING: You went there as President of Halcon.

MENDOLIA: Yes.

BOHNING: What was the arrangement? Where was Ralph? Scientific Design was his original company. Is that correct?

MENDOLIA: Well, as I recall, I was Chairman of Scientific Design, which was still an engineering company, and Halcon was basically the R&D company. Ralph, I think, was Chairman of Halcon. He didn't want to worry about Scientific Design. As a matter of fact, it was interesting. The men in Scientific Design, six hundred or seven hundred people designing

plants, worried that Ralph had abandoned them, [laughter] because he didn't spend much time with Scientific Design. But I learned a little bit about what happens in smaller companies. I think one of the first staff meetings after I joined Halcon, somebody had come up with a proposal to do something. I can't remember what it was. No decision was made in that meeting, and afterward I went up to the fellows and said, "Well, how did you come out in that meeting?" "We're going to go ahead with the project." I said, "But nobody approved that project." They said, "But Ralph never said no, indeed he didn't say anything. That meant we can go ahead." Which said a lot to me about how organizations get signals, and the signals are not necessarily valid, open, and real.

I've had interesting experiences because I worked for a big company, a big part of the government, and then a small company, and they were all different, and you had to adapt. You had to learn to do things that you wouldn't ordinarily do. When I first joined Oxirane here in Princeton, I had a staff meeting, and I looked at this sea of young faces. There were a thousand people in Oxirane at the time. I said, "What's the average age?" Twenty-eight years of age. I was then sixty or sixty-one years old. In my stupid way, I said, "Where's our retirement list?" Well, the next youngest guy was forty-eight. [laughter] But, that's so different from DuPont and the military, where people can retire from forty-eight to fifty-five. You learn to adapt. You learn to adjust. You learn to—well, you learn to learn. That's basically what you do.

BOHNING: Oxirane was a joint venture between Halcon and Atlantic Richfield. Was that already in place when you joined or were you involved in setting it up?

MENDOLIA: No, it was about nine years old. As a matter of fact, it had grown to a billion dollars in less than nine years. It had operations in Holland, Spain, and Japan. In Spain the company was a joint venture with a Spanish petroleum company. In Japan the company was a joint venture with Sumitomo Chemical. The directors in Japan loved to play golf so we used to have a directors meeting in Hawaii at the Hilton Hotel at Wailai. Oxirane had two plants in Texas, one in Bayport, Texas, and one at Channelview, Texas. When I joined Halcon, they were building a new plant at Channelview to make ethylene glycol. Did I tell you that story? DuPont couldn't buy the ethylene during the energy crisis, so Ralph turned to Atlantic Richfield and said, "How would you like to build a two hundred million-dollar ethylene glycol plant?" They did. Incidentally, I don't know whether you know much about Oxirane, but that was an interesting structure. When Ralph went to Atlantic Richfield, the head of Atlantic Richfield Chemicals was a fellow named Bob Bent who went to Penn maybe a year or two before Ralph. I think they had known each other a long time. And then Bob [Robert O.] Anderson, who was the chairman of Atlantic Richfield, set up Arco Chemical at the time. Now, when Bob Bent got Arco Chemical, their biggest product was wax candles. They separated wax from oil in Hamburg, Germany. He was anxious to build a chemical company. When Ralph went to Bob Bent and said, "I will give you my propylene oxide technology if you put up all the money for the plant, but give me a 50 percent ownership of that joint venture." Bob Bent agreed to that. So that was a heck of a deal for Halcon because Halcon got 50 percent of the earnings and Atlantic Richfield got 50 percent, but Atlantic Richfield put up all of the money.

Now, when I joined Oxirane, the plant at Channelview was getting built. It was a big propylene oxide plant, and an ethylene glycol plant. Oxirane owed the banks four hundred and sixty million dollars, which Atlantic Richfield didn't put on their balance sheet because it wasn't necessary if the joint venture was 50 percent owned. As a DuPont guy, I never borrowed from a bank and we were hemmed in by antitrust regulations. DuPont wasn't permitted to buy any companies. I didn't know how to buy a company, nor did I know anything about borrowing money. All of a sudden I've got Chemical Bank, which was the lead bank of a twenty bank syndicate, which had advanced Oxirane four hundred and sixty million dollars. So I got to know banks faster than I expected.

BOHNING: You've indicated some of the problems that you found. You had tech support that only came from the owners. Oxirane didn't have its own tech support.

MENDOLIA: No, it didn't.

BOHNING: Did you change that?

MENDOLIA: Yes. I changed a few things when I got to Oxirane. One is, we were managing our European business from Princeton. Princeton guys loved to travel to London, Holland, and Spain. I said, "Why are we doing this?" So we agreed to set up an office in Eton, England. The engineer we hired to do that job was a fellow I'd been interviewing from Exxon. It took me about a year to persuade Don Wood to leave Exxon and join us. He went to England to build an office building and then manage Oxirane in Europe.

Then we had a fellow who used to be an Oxirane plant manager in Bayport, Texas. We set up Oxirane U.S.A. in Houston. I said, "Look! You're responsible for the U.S." The net result was he wouldn't tell us what he was doing. I said, "Wait a while. You're responsible, but one of the jobs you have is to inform the management on what the hell you're doing." It was tough for him to understand that there's a division of responsibility. One is to do what he thinks is right, but he was obliged to report. It took about two or three months to persuade this fellow that he was obliged to keep us informed on what he was doing. It shows you that this chap had a very narrow focus. When he moved back to Houston—he'd been the plant manager there—he moved to his old neighborhood. Well, he found out that unless he got up at 5:30 in the morning, it was going to take him about an hour and a half to get out to the Channelview plant, because the traffic was so bad. In six or seven years Houston had grown up so much that he couldn't go his old route. Which said to me, this guy had a very narrow focus. But he did a pretty good job in Houston for Oxirane U.S.A.

We finally set up our own R&D. We were the first R&D establishment in the Princeton Forrestal Center. Princeton owned a couple thousand acres there, and they had a plan that they

thought would take twenty years for that site to develop. I think it got developed in ten years, or maybe less than ten years. We were one of the first ones to rent a building. We got an agreement from the owners of Oxirane to build a new research laboratory right behind Union Camp, which is right on Princeton Pike. We bought 50 acres of ground, and we picked an architect to design the building. But the ethylene glycol plant didn't work. We had an agreement to do our own R&D. As a matter of fact, we had a bunch of guys that we had hired to do R&D for Oxirane. The thing that was interesting was, when you had the parents do it, there wasn't any coordination of the effort.

I'll give you one example, and I don't know whether I mentioned it in my talk to Stanford. We had billions of pounds of capacity but nobody was working on process improvements, even small ones, for those processes. So we got probably ten to twenty engineers and chemists, and asked, "What is the likelihood of saving money on process improvements, even though they're small?" After a couple of months, they said, "We think we could save a hundred twenty million dollars." I said, "That's a big number." About six or seven years ago, I went back to some of those same guys and said, "What did you really save?" Well, it came close to a hundred fifty million dollars—because these are large plants. We made two billion pounds of tertiary butyl alcohol. If you improve that by even 1 percent, you can save a lot of money. But the partners wouldn't do that kind of work. They didn't have the people to do that. Atlantic Richfield was an interesting company. It was put together by merging Sinclair Oil [Corporation] with Atlantic Refining [Company] and Richfield Oil [Corporation]. Those companies stayed just as if they were apart, even after they were united. There was no cohesive effort. Not many oil companies do significant R&D. As a matter of fact, it was only after I left Oxirane that Atlantic Richfield built a large R&D facility in Newtown Square, Pennsylvania.

I've got to tell you one other story. A lot of the guys that joined Oxirane were refugees from big companies like DuPont and Monsanto. I said, "Why are you here?" "Well, we just hated a big company." When Oxirane was sold and Atlantic Richfield acquired them, those guys stayed with Atlantic Richfield, which was a big company. So it says if you like what you're doing and you're treated fairly well, you stay. That taught me a lot about what people really think and what they do, versus what they say.

BOHNING: Another thing you found there was what you called an "economic tower of Babel."

MENDOLIA: Yes, that was interesting. I told you that we had a thousand people with the average age of twenty-eight, and we recruited them from everywhere. So a guy who came from Exxon, DuPont, or Gulf [Oil Corporation], all of them had different ideas about what factory cost was or mill cost; they all had different names. We had different names for earnings. You'd think, "God, that ought to be synonymous." So that's where we had to basically put together what we wanted to have said, and then have everybody adhere to it, because we were getting numbers that were hard for me to understand as a DuPont man, because DuPont had its own regulations. I learned pretty easily how soft accounting is. Accounting is very soft. To this day it's very soft. What are the earnings of a company? You read in the *Wall Street Journal* that

Company X, Y, and Z didn't earn much. How come? You've got a big six accounting firm looking over their shoulder. It's because the rules are different. What you can call things is different.

One of the jobs I was given in DuPont was to examine sales expense. El Chem's was higher than the other departments, so I was asked to look into that. Well, I looked into it and I found out the idiosyncrasies of accounting. Textile Fibers, which had a large facility at Chestnut Run, a sales laboratory, decided to call the money they spent out there "R&D", not "Sales Expense." El Chem called their spending out at Chestnut Run "Selling Expense." Theoretically, all these numbers were the same. They weren't the same. They were different. That taught me a lot about understanding accounting.

[END OF TAPE, SIDE 6]

MENDOLIA: Well, you had to educate the personnel. We hired consultants to do that. As a matter of fact, when I went to Africa a couple of months ago, the guy I went with is Ed [Edward G.] Jefferson's son. He trained in the law but he's now with an entrepreneurial company. I told him that one of the publications I got from a guy named Don [Donald] Clifford with the consulting firm McKinsey [and Company] was the definition of a "threshold company." What is a threshold company? Clifford made many observations that were perceptive about threshold companies. A company could be a billion-dollar company and still be a threshold company. It all depends on what you knew and what you did and what you didn't do. We hired McKinsey, and we hired another guy who was a sharp guy, to bring everybody together, which was tough. It took quite a few days of bringing people together who were knowledgeable about our business and unifying them. Did we succeed totally? I doubt it. But we succeeded well enough so at least we got some semblance of uniformity.

One of the things we had to do in Oxirane was to re-evaluate the ethylene glycol process after we'd spent about a year trying to get the process to work. What we made was an economic evaluation, and the economic evaluation said that even if the plant was technically successful, it wouldn't be economically attractive. It wasn't because ethylene prices, which had gone up when the 1979 oil prices went up, hadn't gone up as fast as the energy costs, like oil and gas. We had two huge steam plants, because the ethylene glycol plant had a big recycle stream.

Two-thirds of the material of an eight hundred million-pound-per-year plant was recycled, and the energy costs offset the ethylene yield costs because the ethylene yield was going to be about ten percentage points better than the old processes. So we said, "even if we succeed, we're not going to have a profit." It took a lot of courage to tell the partners that we'd better shut down this plant. That's what caused Oxirane to be sold, because Atlantic Richfield went to Halcon and said, "You've got to put up more equity." Well, Halcon didn't have any equity except its ownership in Oxirane. So the last outfit we thought that would buy the half that it didn't own was Atlantic Richfield. [laughter] So it's now Arco Chemical, which,

incidentally, got spun off in the last couple of months to Channelview, which was another Arco subsidiary. [laughter]

BOHNING: So by 1980 you were out of a job, if I can put it that way.

MENDOLIA: Correct. I was out of a job. But in 1980 I was also sixty-three years old. But I was still walking the Princeton campus most mornings with a man that I had hired as President of Oxirane, Cy Baldwin, a Lehigh chemical engineering graduate. He said, as we walked one morning, "Say, why don't we buy our own chemical company?" I had zero experience in buying chemical companies. He had a lot because he came from Stouffer Chemical, where he had purchased a dozen companies for Stouffer. He also had an encyclopedic knowledge of the chemical business. He knew everybody. A good friend of his was Ray Adams, who was the head of NL Industries, but had come from Mobil [Corporation]. As a matter of fact, one of the statements I've quoted many a time was when Ray Adams retired from NL Industries as the Chairman and CEO, he said, "I'm one of the few CEOs that brought a company from rags to riches and back to rags again," because he sold off all the chemical business, and retained the oil field drilling services. The oil field services went literally bust in the mid-1980s. [laughter] But we bought CasChem, which made Castor Oil Chemicals in Bayonne, New Jersey. Nobody goes to Bayonne because it's not the easiest place in the world to get to. You've got to want to go to Bayonne.

BOHNING: How did you select this particular company?

MENDOLIA: We selected it because it was available. You know, we've said that a thousand times. What do you buy? You buy what's for sale. We set up some rules and we've looked at a lot of companies, by the way, since that time. We said we would buy a company that Cy Baldwin and I at least knew something about. So a lot of businesses we turned down because neither of us knew a damned thing about their end of the business. So most of the companies that we bought—and we bought about twelve plants in the last seventeen years—he and I knew something about the business. Again, as a general rule, when you buy companies, you pay too much for them, so you'd better figure out how you're going to make money from the company that you've paid too much for. That usually means reducing costs or improving products. There's a lot of ways to do it, but you'd better figure out how to do it, or think you're going to do it, because if you don't, you're going to go down the tubes.

BOHNING: What did you see in CasChem?

MENDOLIA: Well, that's an interesting story because in CasChem, their biggest and most profitable product was a polyurethane that had a castor oil base that was used for encapsulating

buried telephone cable, and it had one customer. In 1981 and 1982 Western Electric [Westrex Corporation] bought most of our product. Well, when AT&T was broken up, it affected CasChem because, instead of one customer, we had about fifteen to seventeen customers. Ameritech, which included Illinois Bell, and Indiana Bell had purchasing agents who said, "I'm going to decide what we need to buy." The polyurethane business probably accounted for two-thirds or three-quarters of the profit of CasChem. By the way, the reason we were able to buy CasChem is nobody wanted to buy the castor oil part of the business. They all wanted to buy the urethane, which made a lot of money. But the castor oil chemicals represented the bulk of the plant. We made two or three hundred castor oil derivatives from castor oil that we imported from Brazil in those days. But we made an offer for the whole plant. Now, whether that was a good decision or not, [laughter] I don't know.

BOHNING: So you continued the castor oil business.

MENDOLIA: It's still going on. I went there about six or seven months ago. They tore down a building I said we couldn't afford to tear down, which was the old castor oil extraction plant. Castor beans used to be grown in Texas and Alabama, and then Nixon eliminated the price supports on castor beans probably in the late 1960s or early 1970s. Well, the net result is, with no price supports, the farmers didn't grow castor beans. The castor beans used to be crushed and extracted at the Bayonne plant, and these were big buildings, sturdily built of concrete. I said, "We can't afford to tear those down." Well, the guy that's there now tore those down! [laughter] It cost money! But, yes, we're still using castor oil. I think castor oil was probably one of the first chemicals, described probably in hieroglyphics. We estimate that Cleopatra probably used castor oil, because it's an excellent dispersant of pigments, and it's hygroscopic so that it softens the skin. It's been used for a long time as a laxative. You're probably too young to have taken that.

BOHNING: Oh, I remember it! [laughter]

MENDOLIA: With orange juice as a chaser, it made the orange juice taste bad forever. [laughter]

BOHNING: It was either that or cod liver oil!

MENDOLIA: Cod liver oil, right. [laughter]

BOHNING: That was the other one!

MENDOLIA: Yes. [laughter] But castor oil has been around a long time. It's a secondary crop, so we bought it from Brazil for maybe ten years, and then the Brazilians didn't think it was much of a crop so we now buy it from India. We weren't too happy about buying it from India because it's a long way for shipments. It takes about three weeks to a month for a ship to come from India because it makes stops along the way. But that's where we buy it now.

BOHNING: Are there many other castor oil producers?

MENDOLIA: China is a castor oil producer. We tried to buy castor oil from China, but again, they're still in the dark ages. They have small producers who put it into drums, and there isn't anybody in China yet that takes those drums and empties them into a ship. So China, someday, probably will be a good source for castor oil, but not now.

BOHNING: Once you and Cy Baldwin started on this venture, how quickly did it start to grow?

MENDOLIA: Well, that's an interesting story. We closed on CasChem on December 7, 1981, and we borrowed about 80 percent of the money. We paid thirty-five million dollars, so we borrowed twenty-five million dollars and we agreed to pay 3 percent plus prime. We didn't know that the prime, or the interest rate we were going to pay, was going to go to 21.5 percent, which is what it was in 1982. It's a damned good thing we bought a good cash flow business. We made a small profit in 1982, but I'll tell you, Cy and I had some very sleepless nights in 1982. [laughter] We thought that would be the end of our venture! So it took us probably about three or four years before we bought our second company. It's interesting the way we bought our second company, which was in Carlstadt, New Jersey. Our patent lawyer had some stock in a family owned company. The company made mercury biocides. He said, "I think they would sell if the price was right." That's how we bought our second company.

BOHNING: Was that Cosan?

MENDOLIA: Cosan, yes. We bought Cosan, which was owned by a father and son combination, and that's an interesting tale in itself. Why? Because it made mercury biocides, and the mercury compounds that used it were about as non-toxic as mercury compounds can be, but somewhere around seven or eight years ago, the EPA [Environmental Protection Agency] decided that mercury biocides were dangerous. So they mounted a campaign against the paint companies who used mercuric biocides and forced the paint companies to eliminate this material. By the way, there aren't any really good biocides to prevent fungus formation in paints. So basically, we lost our business. None of this was done legally. The government basically used their clout and threat of litigation to force the paint companies to eliminate it, and

we wound up with no business. It's interesting to me, I don't know, in the last month or so in *C&E News*, there was a big article on biocides (5). There might be a renewal because, again, there aren't many non-toxic biocides that are effective and work in the places where you want material that's water-based to stay active a long time. But Cosan has had its ups and downs. CasChem made polyurethane for buried telephone cable. When optic fiber started to appear about ten years ago, we decided to get into the optic fiber gel business, so we made the material that's used to separate several forms of optic fiber, and we still make that. Cosan makes that material at Carlstadt, New Jersey. Probably that's gradually replacing the polyurethane that's used for buried telephone cable, because that business is going down, down, down. It's optic fiber.

BOHNING: As you extended your purchases, did you have any kind of overall structure, or did each one of these operate independently of each other?

MENDOLIA: No. They operated independently. We were both refugees from big companies and we said that one of the things we don't want to do, if possible, is to put in the bureaucracy and the manuals that tell everybody what to do. It's only in the last probably year or two that each of these plants didn't operate independently. We had no V.P. of R&D in the company. We didn't have any V.P. of production in the company. We didn't have any V.P. of sales. I'll tell you one other interesting thing about buying companies. We rarely bought a company. We bought a plant. Because with a company, you buy a lot of liabilities, and as you know, in the last ten or fifteen years, you buy a lot of environmental liabilities, and they stay with you forever. So we deliberately bought plants. One thing was wrong. When you buy a plant, you don't get a lot of people. You don't get the skilled people in R&D. You don't get the skilled sales people. You don't get the experienced production people. So when we bought CasChem, we had to really move fast to bring back the R&D, which was taken out of Bayonne by NL Industries and moved to Hightstown. But we hired a man who knew where the equipment was, and inside of two months we were able to reestablish the R&D laboratory in Bayonne. We had to hire a sales director. We had no sales people. We had a plant manager. The other thing I learned a lot about starting up your own company is, you didn't know whom to trust. Cy and I signed checks for about a year until we learned enough about our people that we said we can trust this guy. "We're not so sure we can trust that one." When you grow up in a big company, you know the personnel a long time. It's a big difference.

BOHNING: What other areas did you go into?

MENDOLIA: This is one of our failures. One of the companies we bought was called ETD Technologies. We bought it from Economics Laboratory, and the lab was based in a little town outside of St. Paul. The reason we bought it is both Cy and I had had experience in electrochemistry, and we bought a technology that was used for plating copper inside of a long hole in a computer motherboard. A long hole—it had to be a long hole, and evenly put through.

At about the same time, DuPont lost their patents on a masking material that was used to make motherboards, and they were interested in this company. They wanted to sit on our board for six months to a year until they could understand the company, and we agreed. A couple of DuPonters sat on our board for close to a year. One of the things we learned on buying this company is, half of the computer motherboards are made outside the United States, and we didn't have any sales force in Taiwan, China, Malaysia, and Indonesia. But DuPont did. So very early on, Cy and I decided we'd better sell this business whenever DuPont decides to buy it. Well, in about nine months, DuPont decided to buy it and they paid us about what we had in the business.

Well, I don't know whether they still have the business or not, because about a year after I sold the business, I was at the practice tee at the Wilmington Country Club and I ran into the man whose department ETD went into. I said, "How are you doing with ETD?" He looked at me as if he could have stabbed me! [laughter] Apparently his predecessor had bought eight or ten of these small companies and didn't know what to do with them. The new department head was trying to peddle them all. As far as I know, they probably did sell it. But it shows you the hazards of being enamored with technology, because that's what we were enamored with. We had a tough time selling that technology to the people that should have bought it. As a matter of fact, when we sold it there was only one customer and that was the Cray Computer Company because they had a thick motherboard. We tried to sell it to Hewlett-Packard. I went out to Boise, Idaho, where they make motherboards. We couldn't sell these guys, because we didn't know how. The interesting part of this technology is that the ingredient that made the process go only had to be used in parts per million in the plating solution. Now the question is: how do you charge for a few parts per million? We tried all kinds of ways, none of which were successful. Licensing. Royalty rates. None of the of the potential customers would pay for it. So that probably went down the tubes. [laughter] That was a failure.

Another failure we bought was a company in Connecticut that was next to a main highway, probably I-95. The company was family-owned. It was pretty good at tailor-making compounds. But again, they had environmental problems. I've got to tell you one other thing. All the due diligence in the world will never take the place of buying a company and finding out afterward what the seller didn't tell you. You can study 'til hell freezes over and you won't have it. It's only after you've bought it that you find out. As a matter of fact, early in the 1980s, when leverage buy-outs were pretty popular, I had to give speeches, and so did Cy, about leverage buy-outs. I was digging through a DuPont book and I found out information I should have known, that three du Pont cousins bought all of the DuPont Company in 1902 for twelve million dollars from five older cousins that were going to sell out to their competition. The whole deal was done in thirty days, and the closing costs were six hundred dollars, so three guys wound up owning all of the DuPont Company for twelve million bucks. That was a leverage buy-out, because they didn't have any money. They borrowed all the money. So the world hasn't changed very much in a hundred years.

Of course, I'll quote Ralph Landau. He was one of the brightest men I've ever known, he said, "Luck beats brains any day." I said, "How about luck and brains?" "No," he said, "Luck." Which is true, because World War I came along and that made so much money for the

DuPont Company, that Pierre [du Pont] was able to build Longwood Gardens, and Harry du Pont built Winterthur Museum. [laughter]

BOHNING: We were talking about your other purchases and I was going to ask you about Cambrex. Was Cambrex the holding company for all of these?

MENDOLIA: Cambrex was the holding company and the reason we changed the name is that when we got the second or third plant, we called the holding company CasChem Group. Well, that got confusing as hell to people who said, "What is the CasChem Group, and what's CasChem?" So that's when we decided to look for another name, which I did, by the way. Because "Cambrex" has got my initials in the middle and Cy Baldwin's on the outside. The first name I came up with was Cambron. We went to register that name and found out that there's a Cambron family in Florida. [laughter] Registering names is tough because there are four million companies or something like that registered, and you're trying to find one that's unique. [laughter] So, when we went public in 1987, we went public on NASDAQ, and our symbol was CBAM. But then we went to the American Stock Exchange five years later, and they only had three digits. So it was CBM. In the early part of 1998, we went onto the New York Stock Exchange, and it's still CBM. But you know, it's interesting how each organization has got a different set of rules for symbols.

BOHNING: I think you said earlier you purchased a total of twelve or thirteen different companies?

MENDOLIA: Yes. We bought twelve or thirteen, and sold two of them, one to DuPont. [laughter] So I think in the States, we've got about nine plant sites. We have two in England, one in Sweden, and one in Italy.

[END OF TAPE, SIDE 7]

BOHNING: When did you first go international?

MENDOLIA: Probably about six or seven years ago. We bought a plant in Newcastle, England, which had been owned by Hexcel Chemical [Company]. I visited the Philips plant next door when I was with Oxirane. The Phillips plant was refining oil out of the North Sea. I saw it was a huge plant where everything was duplicated. I said, "Why the hell do you have everything doubled?" The man who was giving me the tour said, "If you're taking a million barrels a day out of the North Sea, you don't want to stop refining because the plant is shut down." The seller, Hexcel, was in bankruptcy at the time. Hexcel was a chemical company out

on the west coast. Don't try to buy anything from a bankrupt company. It's tough. [laughter] So that was one. Then it's interesting that we bought the next one from Akzo, a Dutch chemical company. Akzo had merged with Nobel. They call themselves Akzo Nobel. They sold us the chemical operations, which was on an old dynamite site. I haven't been there yet. It's about 150 miles west of Stockholm, and they make specialty chemicals there. As part of that deal, we also got a plant outside of Milan that makes generic drugs. It's a very successful outfit and well run. But again, on a small site. They're adjacent to a little river, and there's no room to expand. So I don't know what they're going to do about expanding. They will probably have to go to a new site.

BOHNING: How do you select these? How do you go about finding what's available?

MENDOLIA: Well, I'll tell you, Cy and I had two things. We had a chemist in Cambrex named Jeff White. He was a Ph.D. from MIT. I first hired this fellow in Halcon. I was impressed with his resume because he was one of the few Ph.D. chemists I knew that got an award when he was ten or twelve years old for selling newspapers. He was an aggressive, bright guy, and he did most of the looking for us. He loved being on the phone. He had contacts around the world. He'd do the digging and the evaluation, and then try to persuade Cy and me that we ought to buy that company. Our first reaction usually was, "No, we don't want to buy that company," but he had a lot of perseverance and patience, and he kept banging away! [laughter] So while Cy was a very knowledgeable guy, the guy who did the original looking was Jeff White. He died of Hodgkin's Disease about five or six years ago, at forty-eight. He thought he was cured, but it came back. He used to go to [Memorial] Sloan-Kettering [Cancer Center] once a week or maybe twice a week for treatment. It was tough. He was a real loss to our company. He was a guy who did a lot of looking and digging for us, probably starting about 1985. He always wanted more responsibility. He wanted to be an R&D Director. I said, "We don't have any R&D." Well, he wanted to be it, because again, he was a damned good Ph.D. chemist. As a matter of fact, the guy who I think is at Harvard now but was a professor at MIT, said that Jeff White was one of the best chemists he ever had. But he was business oriented, and he was damned good at that. He always wanted a better job, and I always had to talk him out of it. I said, "God, you're the most valuable person we've got." I don't think he ever believed me. [laughter] He was a key element in finding companies. Good, bad, or indifferent. He did a lot of the evaluation. He was a pretty good analyst, worked at it, and then his toughest job was selling Cy and me that we ought to buy the company. [laughter]

BOHNING: Is the company still looking for other acquisitions?

MENDOLIA: Yes, it is. As a matter of fact, it's trying to convert itself into a pharmaceutical company. The last acquisition they made was about a year ago, when they bought Bio-Whittaker, which was owned by Whittaker Corporation out in California. They make cell cultures. Probably about half of our sales are drug intermediates or drugs themselves. The

outfit in Italy makes a pretty wide variety of generic drugs that have gone off patent and they're good at it. About a third of their customers are in the United States. As a matter of fact, I asked the president of the Italian company, "How the do you sell companies in the United States?" He said he used to come here, the president of the company, to find the customers. [laughter]

BOHNING: That's got to be difficult.

MENDOLIA: Yes. Well, the president is an Italian that spoke English surprisingly well.

BOHNING: You, of course, were associated with Cambrex, I'm assuming here, until 1995. Is that correct?

MENDOLIA: Yes. No. 1995? That gives me one more story. As a DuPonter, we set a retirement age for directors at seventy-two. Why? Because at annual meetings, which I used to attend, the old du Pont family members, when introduced, couldn't get up and turn around! [laughter] So I said, so after I got two three-year exemptions, "I better not ask for a third," so [laughter] at seventy-eight, I retired from the board.

BOHNING: I'm going to give you a couple quotes and ask you to comment on them. This is just sort of in general now.

MENDOLIA: Okay.

BOHNING: You said, "Chemical engineers are well qualified by training and selection to achieve high places in management of diverse institutions."

MENDOLIA: Yes. As a chemical engineer, you know, I've looked and seen how well chemical engineers have done. The most recent president of Coca-Cola [Company] was a chemical engineer, Robert Goizuetta. They wind up in a lot of different places. The speaker the other night at the ACS meetin, was unhappy with the salary difference between chemists and chemical engineers. As a chemical engineer, I knew practically no chemistry, and less engineering. It tends to attract guys that are generalists, and not technicians most of the time. This is my speculation because I really have never scientifically studied this, but it's amazing how many engineers have wound up in management jobs. Now, I don't know whether that's their inclination or skills. Many skills are learned. They're acquired. I know I learned a lot of skills that I didn't have when I went to college—just didn't. They tend to be more adaptable. I like to think I'm more adaptable, but I'm not sure. When DuPont had an Executive Committee,

they were about half chemists and half engineers. So it says you can't truly generalize and prove it. But there are a lot of chemical engineers that are in high level management jobs where you wouldn't expect them to be, in businesses you wouldn't expect them to be. I say Bob Goizuetta is a good example of that. But, when did he stop being a chemical engineer? Probably a long time ago!

BOHNING: You also said, "The odds of moving up the management hierarchy in a large company are against the average technically-trained person."

MENDOLIA: They are. One of the consultants we had at Oxirane was a friend who had been a personnel administrator for DuPont. One day he sort of shocked me because he came out with a statistic that said in thirty or thirty-five years of experience with the DuPont Company, the average chemist or engineer only moved up two levels out of sixteen. Started at level four, maybe, and he retired at level six. The pyramid is just as steep, whether you've got a hundred fifteen thousand or five hundred employees. So the likelihood of getting to the top is slim. I can't tell you why some people get to the top and some people don't. But I've got to tell you a little story. Crawford Greenewalt wrote a little book (6) that was based on some lectures he gave at Columbia University years ago. It's called *The Uncommon Man*. In there, he relates the story that the Executive Committee, which was about eight or nine guys, could agree that "Joe Doakes" could be a general manager or assistant general manager, but if you asked the eight or nine guys why they thought "Joe Doakes" could, there was no agreement. Each guy saw this fellow from a little different perspective. I've never forgotten that, because it's true. If you subdivide judgment into little pieces, then the consensus disappears, and I've never found that to really change. Intuition—people have started to say intuition is damned important—but it guides a lot of decisions that are made, and nobody really knows what intuition really means. Is it some part of your brain that stores all the information that you've got, and out of it comes some judgment that you've made? I don't know. We'll probably find out in the next fifteen or twenty years.

BOHNING: The last general comment or question that I had was that you've also talked about the differences between large and small companies. In a large company you get a great chance to sharpen your skills, but the progress can be a lot slower.

MENDOLIA: Yes, that's true.

BOHNING: In a small company, you've really got to take some risks and you've got to have a broader picture, and if you don't produce, you're out.

MENDOLIA: You're out. Yes. Well, you know, one of the things I learned when I joined Halcon was that Halcon didn't hire anybody right out of school. They didn't have a college recruitment gang that went out to universities. They hired people with a lot of experience because they weren't geared up to train people. One of the things I learned from the speaker from Exxon was that Exxon has a training program that basically may last a year, where you have put into you knowledge that people have gained over many, many years. Now, Ralph Landau didn't, or other small companies like Cambrex don't. We tend to hire people that have worked elsewhere because we're not geared up to train the people well. That's a big difference. I'll tell you one other thing that I learned at DuPont. I thought DuPont was a good employer. Until one day I learned that we lost 50 percent of the college graduates in the first five years. I said, "God! Fifty percent!" That makes a big difference in terms of your recruiting numbers, because if you're going to lose half of the recruits in the first five years, you'd better raise the number that you've got to recruit. But there's a whole host of reasons why people don't like their company. People will work for three to five companies in their career, maybe more. One of the things that shocked me probably thirty-five or forty years ago is when a man we were going to move from somewhere in New Jersey to someplace else said, "I'm not going to move. My daughter likes her horse riding, and et cetera." That was the first time I can recall we had a guy who didn't want to make a transfer, and that was the beginning of quite a social shift in people determining where their loyalties laid—first to their family and second to their company. That's changed a lot. As a matter of fact, I was, I think, Assistant General Manager of El Chem in 1958 and we had the first big layoff. I think 1958 must have been a depression year. A lot of employees were laid off. Many were men who I knew very well. I'd grown up with them. The general reaction was, "You can't do this to me because I've been with the company ten years." If you last more than a year, you've got a lifetime job with DuPont. The academic community didn't like it worth a damn. We changed our spots a lot as a company because there was a big volatility, for instance, in our engineering department. We used to maybe go up to four thousand employees then back to fifteen hundred. The university said, "We're not going to send you some of our best people anymore unless you make some changes." We made some major changes to level out the employment, and hopefully you didn't have big layoffs. Although, again, that's changed in the last ten years because I think DuPont has let fifty thousand people go since about 1985. I went to my secretary's retirement party where fifteen thousand people were leaving DuPont in one day! [laughter] Again, one of the things that management doesn't know a damned thing about is what skills people have. There's no resume that says, "What does Jim Bohning know that only <u>he</u> knows? That only <u>he</u> can bring to bear?" You just don't know that. There have been attempts to find that out but it's hard, because usually the individual doesn't even know he knows. It's a tough thing to do.

BOHNING: On that note, I've come to the end of my notes. Is there anything that I haven't asked you about that you would like to comment on?

MENDOLIA: Yes, I've had a very helpful and attractive wife for fifty-six years and two lovely daughters and four terrific grandchildren. Jim, you've done a good job in the interview and I've enjoyed getting to know you. Thanks.

BOHNING: I appreciate your spending the time with me today. I've enjoyed it very much.

MENDOLIA: One of the things when you're retired that you have the most of is time! [laughter] I've been a computer jock for a long time. I took a lot of videos in Africa, and I've got four hours worth of shots. But one of the other statements I've said is, if you give a speech, don't have it last more than twenty minutes because the brain can't absorb any more than the seat can endure. So I'm trying to whittle this down to twenty minutes. Well, I don't have the hardware or the software. I'm gradually accumulating it to do video editing. I didn't realize video editing took as much memory of the computer, or space on a hard disk. I've ordered a hard disk drive that's nine gigabytes. Now, that'll only take twenty minutes of movies. Twenty to twenty-five minutes! It's enormous, the amount of data that the sound and the movies take. So I'm going to have to take my four hours, edit it roughly [laughter], and then put titles in it. But I've got videos I've been taking for, I don't know, twenty years or more, with the cameras that were this big, and then small ones. But I've never edited those, so I'm working to do that job.

BOHNING: That's great. Well, again, thank you very much for the morning, and I appreciate the time.

MENDOLIA: Thank you.

[END OF TAPE, SIDE 8]

[END OF INTERVIEW]

NOTES

1. Lisa Boffa, “Everything You Always Wanted to Know About Industry but Were Afraid to Ask,” American Chemical Society Section Meeting. Trenton, NJ, 10 November 1998.

2. Arthur I. Mendolia, “Large and Small Organizations,” Stanford University, 21 February 1990. Typescript copy in Arthur I. Mendolia research file, Oral History Interview #174, Chemical Heritage Foundation, Philadelphia, PA.

3. John Howard Perry, *Chemical Engineers’ Handbook*, 3rd edition (New York: McGraw-Hill, 1950).

4. Samuel Ichiyé Hayakawa, *Language in Action, A Guide to Accurate Thinking, Reading and Writing* (New York: Harcourt, Brace, 1946).

5. M. McCoy, “Biocides succeed despite regulations,” *C&E News* 76, no. 45 (November 9 1998): 21.

6. Crawford H. Greenewalt, *The Uncommon Man, the Individual in the Organization* (New York: McGraw-Hill, 1959).

INDEX