CHEMICAL HERITAGE FOUNDATION

PAUL A. WILKS, JR.

BECKMAN HERITAGE PROJECT

Transcript of an Interview
Conducted by

David C. Brock and Arthur Daemmrich

at

Chemical Heritage Foundation
Philadelphia, Pennsylvania

on

29 October 2002

(With Subsequent Corrections and Additions)

ACKNOWLEDGMENT

This oral history is one in a series initiated by the Chemical Heritage Foundation on behalf of The Arnold and Mabel Beckman Foundation. The series documents the personal perspectives of the individuals related to the history of Arnold O. Beckman and Beckman Instruments, Inc., and records the human dimensions of the growth of the chemical sciences and chemical process industries during the twentieth century.

This project is made possible through the generosity of The Arnold and Mabel Beckman Foundation.

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 Arthur Daemmrich and David Brock on 29 October 2002. 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. X **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 the Work. My permission required to quote, cite, or reproduce.)

c. ______ **Restricted access.** (My permission required to view the Work, quote, cite, or reproduce.)

This constitutes my entire and complete understanding.

(Signature) Paul Wilks
Paul Wilks

(Date) 2/10/03

Revised 7/8/99

This interview has been designated as **Free Access**.

One may view, quote from, cite, or reproduce the oral history with the permission of CHF.

Please note**:** Users citing this interview for purposes of publication are obliged under the terms of the Chemical Heritage Foundation Oral History Program to credit CHF using the format below:

Paul A. Wilks, Jr., interview by David C. Brock and Arthur Daemmrich at Chemical Heritage Foundation, Philadelphia, Pennsylvania, 29 October 2002 (Philadelphia: Chemical Heritage Foundation, Oral History Transcript # 0267).

Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 1910(

PAUL A. WILKS, JR.

1923	Born in Springfield, Massachusetts on 16 June

Education

1941	Springfield Technical High School
1944	B.S., engineering, Harvard University
	(Class of 1945. Graduated in 1944 because of accelerated wartime schedule)

Professional Experience

	Perkin-Elmer, Inc.
1944-1952	Assembler/Designer
1952-1957	Director, Marketing
	Connecticut Instrument Corporation
1957-1962	Co-Founder and Assistant CEO
	Barnes Engineering Company
1962-1963	Manager, Commercial Products
	Wilks Scientific Corporation
1963-1977	Founder and CEO
	Foxboro Company
1977-1979	Manager, Foxboro Wilks Division
	General Analysis Corporation
1979-1993	Founder and CEO
1993-1999	Member, Board of Directors
	Wilks Enterprise, Inc.
1997-present	Founder and CEO

Honors

1981	Williams-Wright Award, Coblentz Society

ABSTRACT

Paul A. Wilks, Jr. begins the interview by discussing his early years and family life in Springfield, Massachusetts. After graduating from Springfield Technical High School, Wilks went to Harvard University where he majored in engineering. In 1945, he began working at Perkin-Elmer, Inc. Wilks worked as an assembler before becoming marketing director in 1952. In 1957, Wilks left Perkin-Elmer and, with Charles W. Warren, founded the Connecticut Instrument Company, a company that manufactured accessories for the infrared industry. Wilks and Warren sold their company to R. Bowling Barnes in 1962. After working for the Barnes Engineering Company for a year as commercial products manager, Wilks left to form the Wilks Scientific Corporation. This company manufactured a variety of spectroscopy products, from accessories to instruments. Wilks hired Anthony C. Gilby, an infrared spectroscopist from England, who helped in the development of these products. This company was sold to the Foxboro Company in the 1970s and Wilks managed the Wilks division of the company until 1979. After leaving Foxboro, Wilks founded the General Analysis Corporation to market products that monitored workspace environments. The company was unable to create a market in this area and changed its focus towards producing products for other industries, such as the beverage industry. Wilks decided to retire in 1993 and General Analysis was eventually sold to OI Corporation. Although theoretically retired, Wilks started another company in the 1990s, Wilks Enterprise, Inc. This company continues Wilks' efforts to produce applicable products based on infrared spectroscopy and other technologies. Wilks concludes the interview with reflections on the state of infrared technology and thoughts about his career.

INTERVIEWERS

David C. Brock is Program Manager for Educational and Historical Services at the Chemical Heritage Foundation in Philadelphia. He is currently a Ph.D. candidate in the History Department, Program in the History of Science at Princeton University. In 1995, Mr. Brock received his M.A. in the History of Science from Princeton University and in 1992, he earned a M.Sc. in the Sociology of Scientific Knowledge from the University of Edinburgh.

Arthur Daemmrich is a policy analyst at the Chemical Heritage Foundation in Philadelphia. He holds a Ph.D. in Science and Technology Studies from Cornell University and has published on biotechnology policy and politics, the sociology of medicine, and pharmaceutical drug regulation. In his research, he brings long-range perspectives to bear on the analysis of globalization, risk, health, and environmental policy. Daemmrich has held fellowships from the Social Science Research Council/Berlin Program for Advanced German and European Studies, and the Kennedy School of Government at Harvard University.

TABLE OF CONTENTS

INTERVIEWEE: Paul A. Wilks, Jr.

INTERVIEWERS: David C. Brock and Arthur Daemmrich

LOCATION: Chemical Heritage Foundation
Philadelphia, Pennsylvania

DATE: 29 October 2002

DAEMMRICH: This is an oral history interview with Paul [A.] Wilks, Jr. on 29 October 2002 in Philadelphia, Pennsylvania.

BROCK: Please begin by telling us about your family background and your youth.

WILKS: I grew up in Springfield, Massachusetts. My father was a financial officer at a paper company. My mother, a teacher, taught shorthand and typewriting at the local Commercial High School. Springfield was unusual in that it had five high schools within a stone's throw of each other—Technical, Commercial, Classical, Trade, and Cathedral. I went to Springfield Technical. I had always aimed toward attending Harvard [University] because my father said he'd pay my way to Harvard. I was in an unusual predicament because everyone who went to Harvard from Springfield graduated from Classical High School. But I was accepted.

I arrived at Harvard in 1941, just before the incident at Pearl Harbor. I majored in engineering, which can no longer be done at Harvard. In fact, majoring in engineering was discouraged even in those days. From my point of view, I had the perfect education because I was interested in technology, but I also wanted a fine arts background. The best course I ever took at Harvard was English A, where I had to write a theme a day. That course taught me how to write and was probably one of the most useful courses that I took while I was in college.

I was deferred from military service because I majored in engineering. Even though I tried to enlist, the military said, "Continue your engineering courses because we need engineers." In my junior year I had an operation that removed a portion of my chest, which, when I graduated, classified me as 4F. And for that reason, I have no military experience.

During the War [World War II], my father was an ordnance officer operating out of the Springfield Ordnance District, which covered all of New England. He always spoke of a small optical company in Glenbrook, Connecticut, that was manufacturing optics for gun and tank sights at twice the quality and half the cost of any other optical company. When I became a senior, my father informed Dick [Richard S.] Perkin, a friend of his, of my technical interests. Dick replied, "Have Paul come down and talk to me."

At that time, I was being interviewed by two other companies—General Electric [Company] and Carrier [Corporation]. I was leaning toward Carrier because they had just started in air-conditioning. I remember taking the train from Boston to Stamford, going along the shore—I have always loved the water and had spent my summers in Newport, Rhode Island, because I enjoyed sailing and boating—and I became more and more intrigued by Perkin-Elmer [Inc.] as I got closer. I arrived, had lunch with Dick, and was shown the plant. I decided that that was where I wanted to start. Dick talked to me about a new technology known as infrared [IR] spectroscopy. He didn't know much about it, but said, "We're working with [American] Cyanamid [Company]. Infrared spectroscopy looks like something that's very important. Maybe you'd like to get involved."

DAEMMRICH: If we could go back to your family. How long had your family been in Springfield, Massachusetts?

WILKS: My father came from Newport, Rhode Island, and went to Harvard. My mother came from New Hampshire. My father came to Springfield to work for Milton Bradley [Company], the toy manufacturer, around 1920, and my mother arrived in Springfield at about the same time. She went to Smith [College] and got a job teaching at Springfield Commercial High School. They met in Springfield and spent the rest of their married life in Springfield.

DAEMMRICH: If you think back to high school, were you already interested in chemistry or engineering?

WILKS: Yes, I did very well in chemistry. I was more interested in physics and, in fact, when I went to Harvard, I initially started to major in physics. But I decided that physics was not down-to-earth enough, so I switched over to engineering, which was more practical. Here is an interesting experience: when I was a junior, I received a postcard in my mailbox stating that dean so-and-so would like to see me at two o'clock next Thursday afternoon. I wondered, "What the heck have I done wrong?" When I went to see the dean, he had some records in front of him. "Wilks," he said, "you got a perfect SAT [Scholastic Aptitude Test] score in chemistry. Why aren't you majoring in chemistry?" Here I was a junior, and I said, "Well, I just liked engineering better." "Well," he said, "I can't understand why you're not majoring in chemistry" and that was the end of the interview. [laughter]

Anyway, Dick Perkin convinced me that Perkin-Elmer was the place for me to be—I learned later on that he could talk anyone into working for him. He constantly asked, "Who do we need here?" We replied, "So-and-so." He disappeared and three or four months later he said, "He's coming next week." He was that good. I arrived at Perkin-Elmer in July 1944. I was in the class of 1945 at Harvard, but during the War I went through in three years. John White and I joined the company on the same day. White came from Esso [Corporation, formerly Standard Oil Company, now owned by Exxon Mobil Corporation].

My first job was to go to the machine shop, which was in downtown Stamford, and assemble the first infrared spectrometers that Perkin-Elmer was developing. The Model 12. I put together the first fifty-odd instruments that they produced. I remember Dick Perkin telling me that he thought there was a market for twenty-five instruments. Our initial production run was twenty-five instruments, but when we got halfway through, we had a backlog of sixty-five! [laughter] That was my first job—assembling the Model 12.

DAEMMRICH: Who showed you how to assemble the product?

WILKS: Curt Oppermann, a mechanical genius, supervised the machine shop. The machine shop, where I was in downtown in Stamford, was separated from the optical shop in Glenbrook. After I assembled an instrument, I took it to the optical shop in Glenbrook, put the optics in, did the final alignment, and whatever else was needed. From there the instrument was shipped out. I remember very clearly working Saturday mornings in those days. Two or three Saturday mornings, when Dick Perkin came in, I'd be assembling an instrument. "Is it ready to go?" he'd ask. I'd reply, "Yes." Then the two of us would go out to the shipping department, put the instrument in crates, put it in the panel truck, and take it down to the Railway Express Agency. When we finished, Dick would say, "Well, that's next week's payroll." [laughter]

This was right at the end of the War when all the government contracts for optics were being reduced and canceled. So the infrared instrument was what kept the company going for a few months. Perkin-Elmer also had a relationship with a group on Long Island that developed telephoto lenses. The Long Island group did the optical design, the lenses were polished in the optical shop at Perkin-Elmer, and the final assembly took place there as well. Back then Perkin-Elmer was split into two product divisions: the telephoto lenses and instrument, which produced the Model 12. Both groups grew very well but were separated in the marketing—the optical division worked mostly for the government; the instrument division worked mostly for industry.

After I'd been at Perkin-Elmer for about three years, I said to Dick, "You know, we've been running the same advertisement in *Analytical Chemistry* for the last two years." He asserted, "That's right. I'm hiring a new advertising agency and I'd like you to talk with them." Thus, I went to New York and met Fred Wittner [of Fred Wittner Advertising] from the new advertising agency. From then on I was in charge of advertising at Perkin-Elmer. I hired Jack O'Connell to take my place assembling the Model 12.

I moved into advertising, and, for many years until I left the company, I was in charge of Perkin-Elmer advertising. I had built up a group that had public relations, market research, and advertising associated with it. Wittner was a big advocate of house organs and he talked us into publishing *Perkin-Elmer Instrument News* [*for Science and Industry*]. For the first several years I wrote every bit of that publication. It was published quarterly and contained information on applications, studies, and the like.

BROCK: May I interrupt to ask a few questions? I am interested in your decision to go to Technical High School. Was that because of your youthful proclivities toward technology?

WILKS: Yes. I had a Model A Ford [Motor Company] Roadster, which I loved. I took it apart and replaced all the rings and valves. I liked working with my hands. I enjoyed the technical side of things. My interest in how things worked led me to Technical High School rather than Classical High School which focused on arts and languages.

BROCK: During your time at Harvard studying engineering, did you take a variety of courses on the different types of engineering or did you focus on one aspect of engineering?

WILKS: The curriculum was mostly mechanical, but one course that really helped me later on—and I had no reason to believe it was going to—was crystallography. It was the only course I ever got an A in. The course detailed the study of crystal structures. When I got into infrared—well, we were looking at molecules—that crystallography course helped me to understand what was going on. Another course which I thoroughly enjoyed was English. I have always been interested in doing things with my hands and trying to figure out what makes things work. That led me into engineering.

BROCK: Did you have any professors or mentors who encouraged you to pursue a technical career?

WILKS: Not really. I had good professors, but I don't remember being particularly close to any of them. The one course I didn't take but wish I had was organic chemistry. I took a course in inorganic chemistry, but organic chemistry would have helped me later on. My whole career has been involved with organic chemistry. I took another course that was very interesting. Professor [Richard] von Mises gave a course in aerodynamics. I'm not sure that that helped me later on, but it was fascinating to learn how a plane gets off the ground.

BROCK: You spoke about Dick Perkin's ability to charm anyone he wanted to into joining the firm. Could you give us your impressions of Richard Perkin and his role in 1944 when you joined the company?

WILKS: I got to know Dick very well because he was a sailor. He had a Starboat on which I was his crew. Every Saturday and Sunday I went out sailing with Dick. Dick was the kind of person who everyone liked. He had a wonderful personality, but was a very poor administrator. What he tended to do was to hire a person, put him in the company, and then let him find his own way. This caused a lot of dissension among those he had brought in. Both Max [D.] Liston and John White had no use for Van Zandt Williams. Van Williams was an associate of [R.] Bowling Barnes at Cyanamid. Van was another person that Dick decided should join the company. Cyanamid was contracting their instrument development activity so both Barnes and Williams left. Barnes set up his own company [Barnes Engineering Company]. Dick Perkin told me, “Go over and talk to Van.” I knew Van from Cyanamid, because we worked together in the development of instruments. I remember Van asking me, “What am I going to do?” I replied, “I don’t know. Perhaps Dick wants you to be director of sales or something like that.”

But Perkin never made it absolutely clear what Van’s responsibility was going to be. Both John White and Max Liston, who had come to the company a couple of years before Van, were both thinking they ought to get the head engineering job, but neither of them did. I remember very clearly the day that we finished the Model 21, both John White and Max Liston went to Van and resigned. They had finished their job and decided they didn’t want to stay with the company.

John stayed on a little bit longer because when the Model 21 was completed—I’m getting ahead of myself a little bit, but the Model 21 got started because Norman Wright at Dow [Chemical Company] had created a double-beam instrument with his group. Van and John went out to Midland to look at that instrument and came back and decided the double-beam system was the future of infrared. The double-beam avoided a lot of problems that the single-beam instrument could not, so they immediately started a program with White, Liston, and later on [Vincent J.] Vince Coates doing the development work. When the first instrument was completed, they drove it to New York, put it on a lower bunk in a sleeper car, and took it to an Optical Society [of America] meeting in Detroit. They practically hand-carried the instrument into the meeting in order to show it off. Then when they came back, both John and Max decided to leave the company. By that time, infrared had become the major aspect of Perkin-Elmer’s business. Perkin-Elmer had gone into electrophoresis as another analytical technology, and had made a flame photometer, which was the precursor of the atomic absorption instrument. That was quite a good instrument and I spent some time teaching people how to assemble it and use it, but I basically stayed on the infrared side.

DAEMMRICH: Help me with the sequence at Perkin-Elmer. You arrived and assembled the Model 12. Then you headed advertising and wrote the house journal.

WILKS: Yes. Actually, I moved out of assembly and hired Jack O’Connell to take over my job. Then I basically went into sales. Vince Coates and I both were Perkin-Elmer salesmen. We covered the United States. I had Canada and the East Coast, Vince had the central part of the country, and I had the West Coast. But Van Zandt Williams’ idea of sales was, “You don’t call the customer. If they’re interested in buying one of your instruments, they come and visit you.” [laughter]

DAEMMRICH: So you didn't do much traveling.

WILKS: I did a fair amount. I used to take a sleeper out of Stamford. You could get a train right up the Connecticut River into Montreal which left at eight o'clock at night. I'd be in Montreal by seven the next morning and ready to go out to the oil refineries in Montreal East. I got to know Canada very well. I traveled into New Jersey, which was a very good area for instrumentation. I also went to Maryland.

DAEMMRICH: You weren't selling your technology to academics?

WILKS: No, my visits were primarily to industrial companies. Now, we had good sales to universities like [University of] Minnesota and MIT [Massachusetts Institute of Technology], but the real business, at that stage, was to the DuPonts [E. I. DuPont de Nemours and Company] and the Cyanamids. DuPont was probably my closest associate as far as a customer is concerned. I spent a lot of time down there. Later on I'll go into some of the results that came from the DuPont relationship. DuPont and Perkin-Elmer were very close, so I spent a lot of time in Wilmington.

BROCK: Was it in 1945 that you began in sales?

WILKS: It was probably around 1952. The Model 21 came out in 1952 and that was our big product. The Model 12 was sort of in the background by that time, so the 21 was it.

This reminds me of a story. On one of my sales trips, I stopped at the United States Department of Agriculture Experimental Station in Beltsville, Maryland. I was following up on an inquiry that I had received from Dr. Carl Norris. Although Carl had a Cary [Instruments, Inc.] ultraviolet spectrometer, it wasn't sufficient for some of the food analysis tests that he wanted to do so he was interested in the Model 21. Unfortunately, government funds were limited and Carl wasn't able to find the eleven thousand dollars that he needed to buy the Model 21—this situation had both good and bad consequences. The bad consequence was that it would be a number of years before mid-infrared spectroscopy would be used for food analysis, but the good was that Carl was forced to use the equipment that he already had and became aware that the NIR [near-infrared] region of the spectrum could be very useful. His work opened up a neglected region of the spectrum and helped to spark a whole new industry. I wonder if this would have happened if he had been able to purchase the Model 21!

In the mid-1950s, I received an invitation to go to DuPont to meet with a group there. They were good friends of mine. I remember that they took me out to lunch at the DuPont Country Club and told me, "Where we're sitting is going to be the new Experimental Station. Over there will be a new golf course. We have to build a replacement golf course before we tear up this one." Then they said, "We're going to design the Experimental Station so that it has analytical alcoves in all the buildings and we want to put an infrared spectrometer into these alcoves. But the Model 21 is too big and too expensive and the Model 12 is not versatile enough. Neither is the right instrument. We need a simpler instrument to put in these alcoves."

I remember sitting on the train coming back thinking about it and thinking that we could build that simple instrument that DuPont wanted simply by taking a lot of the controls and the variability aspects of the Model 21 and making them smaller. I came back, sat down with Dick Perkin, and said, "Here's a real opportunity. The world needs this instrument." His attitude was, "You're going to kill the golden goose because the Model 21 is our mainstay. If we bring out something to compete with it that's far less expensive, we're going to be in big trouble."

It took me two years to convince the company that this instrument was needed. The push to move ahead came when we heard that John White had been hired on as a consultant with Beckman [Instruments, Inc.] and that they were developing their IR-5, which was going to be a low-cost infrared instrument. Anyway, we finally got the Model 137 out and that became the basis for the Perkin-Elmer infrared product line from then until the mid-1980s when they came out with their FT-IR [Fourier transform infrared] instrument. The 137 was expanded and went from prisms to gratings. It went through a whole series of improvements and was the basic IR product line for Perkin-Elmer for many years.

Around that time I began to get a bit itchy. The company had a hierarchy. There was Van Williams, Carl Miller, the head of engineering, Vic Harris, the head of production, and John Hughs, the chief financial officer. They were the managing committee of the company and I was down at the next level. This structure bothered me because I could never get into the Monday morning meetings where I could contribute to planning the growth of the company, so I began to think that maybe I could come up with a product line that could create a new division within Perkin-Elmer that would give me an opportunity to build something myself within the company.

This was about the time when television [TV] was just getting started and one of the Perkin-Elmer optical engineers had developed a zoom lens. It was a big bulky thing, but it worked very well. It created a way to zoom in on a football game and bring the action from panoramic to up close. I also began to study the television industry to learn about the format of the lenses being used, because the image orthicon tube used in those days was a little bit larger than the standard 35mm camera. To me this was a wonderful opportunity for Perkin-Elmer to get into a totally new field—they had the optical designers who could modify lens designs to meet TV requirements, they had the optical polishers, and they had this wonderful zoom lens, which was really needed by the industry.

I found out that RCA [Radio Corporation of America] down in Camden, New Jersey was the leader, at this time, in cameras for the television industry. I arranged a meeting with RCA and talked Dick Perkin into going down with me for the visit to Camden. I was promoting the ability of Perkin-Elmer to build optics for the television industry and trying to form a relationship between RCA and Perkin-Elmer. In the car coming back, Dick Perkin was quiet for a very long time. We were going up the New Jersey Turnpike when he finally looked at me and inquired, "Did you realize that most of those people that we were talking to were Jewish?" I said, "I didn't notice, Dick." He responded, "I don't really want to do business with that kind of an organization."

That was the end of that project as far as Perkin-Elmer was concerned. That never went any further, but I think they could have done a wonderful job. This turned me off because here was the thing I thought that I could develop within Perkin-Elmer and I couldn't get anywhere. Within a year, I decided that I would go off and do something else. Perkin-Elmer had bought a company in New Jersey—Warren Electronics, which was an ultraviolet [UV] company. Perkin-Elmer had never really been involved with UV, although we built a modification of the Model 12 for Esso based on UV.

I want to go back a little bit, because around that time I got to know Howard [H.] Cary, who had left Beckman to start his own company, quite well because we met at trade shows and had dinner a couple of times in California. Cary was a very nice guy and I thoroughly liked him. Once Cary came to me and asked, "What would be the possibility of putting my company together with Perkin-Elmer?" So I talked with Dick Perkin because I thought this would be a wonderful combination. I said that Cary would bring his West Coast, ultraviolet operation into the company. Dick was quite interested, too. I probably made three trips out to Pasadena to talk with Howard to try to put things together. It looked like a very good possibility.

[END OF TAPE, SIDE 1]

WILKS: However, the partnership didn't happen because Van Williams, at that time, was very ambitious and wanted to be executive vice president. It turned out that Howard Cary's salary was about ten thousand dollars a year more than Van Williams, and Van didn't want Cary to come into the company and take his place.

Van had no use, really, for the ultraviolet region. Once, in order to introduce a new instrument, Van made a presentation to a group of publicists and a member of the press asked, "Why isn't Perkin-Elmer involved with the ultraviolet?" Van responded, "Here's why," as he held up his hand with his thumb and forefinger about four inches apart, "here's the ultraviolet region of the spectrum and here's the infrared region. There's so much more information in the infrared region than there is in the UV."

Of course, in those days we looked at wavelength instead of frequency, so the UV wavelength region was small and the infrared wavelength region large, but if you look at frequency the way we do today, it's reversed. [laughter] But anyway, this was his point and he was right. There was much more information to be gained from infrared than from UV. That's why he thought Perkin-Elmer should concentrate there.

One other thing that we worked on that I had a lot to do with was trying to develop on-line infrared instruments. We had a program to develop an on-line gas analyzer and a liquid analyzer that could be plugged into the side of a chemical process. The first installation we made was in a Cyanamid plant in New Orleans. We learned that the chemical we were going to use to control the process was the wrong chemical. But, that was one of the things you learn when in process control. Well, Dick had no interest in process monitoring. He wanted to strictly stay in the laboratory, so we never really got very far with the process business.

The other technology that developed during this time was chromatography. I was still with Perkin-Elmer when gas chromatography [GC] appeared. This I remember very clearly. I took a trip to the Texas oil fields because we were beginning to sell infrared instruments to the operators there. The Texas refineries were trying to characterize the petroleum that was coming out of the ground and were using a Model 12 instrument to do so. The Model 12 worked, but the process was time consuming. I went to St. Louis to give a joint paper at the American Petroleum Institute with a friend of mine from Baird [Corporation] who was doing the same type of work. When we met at the airport he said, "Paul, we're wasting our time. Our guys just came back from England where they heard about this new technique based on the separation of chemicals. You look at each chemical individually in order to do quantitative measurement much easier."

I gave my paper and came back to Norwalk where I discovered that Harry [H.] Hausdorff had also heard about this new technique, so we had a meeting. We all got together and said, "This is nothing but a bunch of plumbing. There's no optics in it. It's really a very simple instrument. Therefore every instrument company in the country is going to come out with a GC instrument. So we'd better come out with ours as fast as we can." Really, Perkin-Elmer had a six-month program. This was in May or June and by the next Pittcon [Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy], we had our first GC instrument. We called it a Vapor Fractometer because gas chromatography is a misnomer. You're not dealing with gases. You're dealing with vapors and it's not a chromatograph. It's a fractionater. It breaks up a mixture into its components. But, the name never stuck! [laughter] Everybody called it GC.

At that stage, I began to realize that GC and infrared belonged together. You could separate a mixture into its components, but you couldn't identify them with a GC. If you could take these separated components and put them through an absorption cell in an infrared instrument, you could get a spectrum of each component as it appeared. I wrote an article, which was published in *Instrument News*, stating that GC and IR belonged together. I think that my article was the first recognition that these two technologies could work very well together (1).

BROCK: They were using conductivity detectors?

WILKS: Right. Well, I'll talk more when we discuss CIC [Connecticut Instrument Company] and its connection with GCIR [gas chromatography infrared spectroscopy] later, but we spent a lot of time in some of my other companies building sampling equipment that tied the two technologies together. In the early days, GC used quarter-inch columns and there were big slugs of sample that came through, so we used a gas cell—we conceived of the light pipe gas cell. This was first done at CIC. We could use a long light pipe gas cell, so that as the fraction came out of the column, it filled the cell; we speeded up the spectrometer so we could get a spectrum in two minutes and characterize the components as they came out of the chromatograph. In fact, we even tried to convince the GC people they should develop a start-stop chromatograph. You know, when one peak comes out, stop the process for a minute so that one could get a spectrum of it. But that was after I left Perkin-Elmer.

About this time, as I said, Perkin-Elmer purchased a company called Warren Electronics. Chuck [Charles W.] Warren was the president. He was an entrepreneur and wasn't very comfortable at Perkin-Elmer either, so the two of us did a lot of talking. We finally decided that we would leave and try to set up a company on our own. We searched around for something to hang our business on and we thought of various types of instruments, but we both got interested in ultrasonic machining because we were interested in glass and UV and IR transmitting crystals. We decided to get an ultrasonic machine and then offer the services of machining glass for various applications.

We formed a company called Connecticut Instrument Company, CIC for short. We set up a shop about half a mile north of Perkin-Elmer on Route 7 and got a contract making Sidewinder dampers. These were glass disks that had two grooves containing mercury—a little bit of mercury in each of the grooves with a cover melted on top of it. It was used as a vibration damper inside the Sidewinder Missile—the mercury moved to counteract vibration. We made several thousand of these under contract with a company in New Jersey.

About that time I got a letter from a very close friend of mine, [R.] Norman Jones. He was a Canadian infrared person. He's now deceased, but he was working for the National Research Council in Canada. He sent me a paper, which is in the archives that I've given you, with "Best wishes from Norman Jones" written across it. It was a description of how to make an infrared absorption cell by means of ultrasonic machining—a cavity cell. I'm always interested in trying to get the costs down on things, make them less expensive and more widely used, so this fascinated me. We had the equipment, we had the ultrasonic machine, and Chuck and I spent a lot of time figuring out how to put a cavity in a piece of rock salt. We learned how to do this and it became quite a product. I remember taking it to Pittcon in my pocket and showing it to my friends there.

One thing led to another. We had to learn how to polish rock salt to make the cavity cells. Then we discovered that we could also grind and polish windows for infrared spectrometers. Very quickly it occurred to me that there was a market for a company that did nothing but accessories, because the big companies were concerned with making instruments and that was what they were good at. So, the cavity cell led us into a whole line of infrared accessories. At CIC, we developed accessories that are still being used today. Everybody uses cells where you screw the top on over two windows and spacers, which we called "FT" cells for final thickness. This was all created at CIC.

Van Williams called up one day and stated that he wanted to come and visit me. He did and I showed him our shop. Van said, "Paul, you're really doing us a favor because you're creating accessories that help sell our instruments. We can't mess around with hundred-dollar items. We're selling ten thousand-dollar instruments and that's the way of our business." He was very supportive of us and we did a lot of work with Perkin-Elmer and Perkin-Elmer customers. So, a company that started off doing ultrasonic machining turned into an infrared accessory company.

DAEMMRICH: When you left Perkin-Elmer, who funded you?

WILKS: A very interesting question. Charles [W.] Elmer owned a third of the company. Dick Perkin owned two-thirds. When he died, Charlie Elmer left his one-third interest to be resold to the Perkin-Elmer employees. All of us who were employees at the time got a certain number of stock shares based on our salary. I remember my wife being very upset because I put twenty-five dollars a week into buying Perkin-Elmer stock when my total salary was sixty dollars a week. [laughter] But that gave me a kitty so that by the time I left the company, the stock had appreciated a great deal, and I had enough resources to get CIC started. Chuck Warren also had gotten some money when he sold his company. Between the two of us, we probably each put in five thousand dollars to start the company. This was in 1957. I left Perkin-Elmer in 1957.

We didn't stick with the ultrasonic machining very long, except for making cavity cells. Ultrasonic machining turned out to be much more difficult than we had anticipated. As soon as we got going in the infrared accessory field, the company began to move.

DAEMMRICH: In terms of finding customers and reaching them, how important were the Pittcon meetings?

WILKS: Not only is Pittcon a place to meet potential customers, but it is a place to get new ideas from people who drop into the booth. It's also a place to check up on your competitors!

Anyway, CIC did very well. We got into the accessory business and I had another one of these experiences. You know, you learn so much at shows. Every time I go into a show, I learn about something new. It's not talking to customers so much as it is hearing about new technologies. We had an exhibit in New York City around 1962 at the Eastern Analytical Society. A fellow named Donald Johnson from DuPont came into our booth and said, "Paul, there's a new technology that you ought to look at called attenuated total reflection [ATR]. It was developed by Shell [Chemicals, Ltd.] in Holland and our people are very excited about it. You're in infrared accessories. It opens up a whole new way of sampling." Abe Savitsky of

Perkin-Elmer came by the booth a little later and said, “We just heard about this, too.” I gave him a ride back to Norwalk and all the way back he talked about this new technology.

Well, we looked into it and decided that we were going to do something, so we went ahead and designed an attachment that fit into a spectrometer. It had a prism made out of silver chloride. We decided that it was the best material because one could clamp a sample on the back, put it in the instrument, and get a spectrum. This was the first commercial application of ATR; today ATR is probably the most widely used sampling method there is.

By that time Chuck Warren and I had decided that we didn’t really like working together. We were friendly enough, but he wanted to go off into UV and I wanted to go into infrared, and Bowling Barnes had been after me for a year to talk to Chuck about selling. I finally talked to him and we decided to sell the company to Bowling Barnes.

We were in the process of signing the papers when Barnes said, “Now, we want a guarantee that you’ve disclosed all the bills and liabilities—everything.” I said, “Well, of course we have, but I don’t want to sign anything that—” but my lawyer interrupted me and said, “I want to talk to you.” He took me out in the hall and demanded, “Is there anything under the rug that you haven’t disclosed?” I answered, “No.” He continued, “What are you worried about? I’ll tell you what we’ll do. You ask for something in return. They want you to sign an agreement that for two years you’ll be liable for anything that comes up. What would you like to get?” I stated, “They’re after me to give them a three year no-compete contract. Maybe we could shorten that to a year.” So we went back in and my lawyer declared, “Wilks will sign this providing you reduce the no-compete from three years to one year.” No question—they were glad to do it.

I stayed with Barnes for just about a year, because I didn’t fit into the company politics. [laughter] So I left, and got involved with Jim [N. James] Harrick. Jim was very fascinated by internal reflection spectroscopy. He was the number two guy after Jacques Fahrenfort. Harrick wrote this wonderful book, which we still use today (2). He invited me to Philips [Research] Laboratory, which was close to us in Tarrytown, New York, to show me the multiple ATR design, which provides multiple reflections instead of a single reflection and was what we were using at CIC, and which increased the sensitivity of the measurement.

Well, we developed an attachment with a multiple reflection ATR, which was our first product at Wilks Scientific [Corporation]. It took us almost a year to get it out and Barnes kept telling me, “You’re competing. You’re competing.” We even changed the name. We called it “frustrated multiple internal reflection” instead of “attenuated total reflection.” Anyway that became the first product of Wilks Scientific Corporation and was based on ATR. At both companies we did a lot of work on GCIR products, too. At Wilks Scientific, I took a Perkin-Elmer 137, removed the source optics, and put a light pipe between the source and the entrance slits so that we could pump effluent from a GC through it. That was the first IR spectrometer that was dedicated to doing GCIR work.

During that time, Myron [J.] Block got in touch with me. He wanted me to come down to Maryland where they were putting together their first FT-IR instruments. They were convinced that FT-IR and GC belonged together because FT-IR was so fast. They could make very rapid scans and get these peaks as they came out of the chromatograph. We taught them how to make light pipes to go with that instrument. I had discovered that we had to use rectangular light pipes with a slit instrument, but with the FT-IR one could use circular light pipes, which are a lot easier to make. But, we really got the world started on using light pipes for various types of application in the infrared.

BROCK: By light pipe, you're talking about something like a gas cell, right?

WILKS: Yes. It's just a gold-plated tube. They function because you don't need focusing optics or anything like that. The energy bounces down the inner surface until it gets to the end and then it comes out the same way it went in. If it's compressed going in, it expands coming out. It just means that you can get a long path, fill it with gas, and read a very low concentration. We use light pipes all the time today for various purposes. Anyway, that's where it all started. I've gone from CIC to Wilks Scientific, which we started in Norwalk—actually in the same building I'm in right now. Back then that building didn't have the front two-stories on it, but we rented space and gradually took over.

DAEMMRICH: In terms of the relationship with Barnes, was there a longer history to that or was it simply that he walked into a meeting and said, "I want to buy your company?"

WILKS: He'd known me for quite a while and had watched us grow—I knew him at Cyanamid. The reason he wanted to purchase our company was that Barnes Engineering was totally military-oriented and into infrared. They made infrared detectors, batometers, and the like. He wanted to get a commercial business into the company. He thought he could balance the military work. That's why he was interested in CIC—we were totally commercial. It looked like a good fit as far as we were concerned. What I learned when I got there was that the people who were running Barnes wanted no part of a commercial business, because they were so busy doing work for the government. This is typical with companies that do business with the military—there's a way of doing business there and they don't understand the nitty-gritty commercial side. I just couldn't find a niche in Barnes that was comfortable. I only lasted for a year and then I told Bowling, "I think I'm going to go do it again." He had the product line from CIC and finally ended up selling the product line that he'd bought from me to Don Sting. That is the history of it. As I said, I'd known Barnes for many years and he was a great guy. You'd go into his office and spend half the morning there because he talked—you'd have to let him talk. [laughter]

Wilks Scientific was the second company that I started. We, again, went into infrared accessories, this time based on a little more complex instrumentation—ATR devices of various sorts. We developed horizontal ATR, which is what everyone uses today. Horizontal ATR has a flat surface that you can put a sample on, as opposed to a vertical surface like the early instruments.

DAEMMERICH: Whom were you selling to?

WILKS: Again, the industrial market primarily because we were trying to give them practical equipment to solve problems. We were trying to get beyond just making accessories, so I hired an infrared spectroscopist, Anthony [C.] Gilby, from England. Gilby was educated at the University of Minnesota. Gilby was very interested in applying infrared to various applications, so I went over and had dinner with him in England. We got together and I asked him if he'd like to come and work for us, and he did. He brought to the company an ability to design optics and he was a good mechanical designer. He was a heck of a good scientist really. Tony and I went out to a Pacific Coast spectroscopy meeting in Anaheim, California. There was an instrument there that was introduced by Beckman—a rapid scan infrared spectrometer designed to look at GC fractions as they came out.

We have to go back a little bit in history because there was a big rivalry between Perkin-Elmer and Beckman. The fundamental difference between the two companies—Perkin-Elmer understood aspheric optics. Perkin-Elmer had Halley Mogey who could make off-axis parabolas, which meant that they could use a very low f-number in their optical design, like f2.5. What that means is that the smaller the f-number, the bigger the numerical aperture, and the more energy you can pump through your optical system. This is always a problem in infrared. It's always energy-limited. The more efficient optical system you have, the higher the signal-to-noise ratio and the more you can analyze. Beckman did not have this optical skill. Their instruments were f10 instruments, so Perkin-Elmer always ran circles around Beckman for that reason. They had one hundred times as much energy to work with as a typical Beckman instrument, and therefore they were that much more sensitive.

When Tony and I looked at the Beckman instrument that they had introduced as a rapid scan instrument, we saw that it had a circular variable filter [CVF]. The CVF is a filter that has segments. As you scan across each segment, the wavelength that is transmitted by that segment changes, so you can rotate this filter in a beam and create a rather crude infrared spectrum. They were using this filter to look at the effluents from a chromatograph, but it was an f10 system. It had a very bad signal-to-noise ratio. Beckman was not happy with it so they discontinued it. But I was fascinated because it showed that there was a way of making a poor man's infrared spectrometer.

[END OF TAPE, SIDE 2]

WILKS: Using the CVF with short focal length optics—f2.5—we could select any wavelength we wanted to make measurements on different materials. It was a way of making a very inexpensive, but very versatile infrared analyzer. I learned that the filter was manufactured by a company on the West Coast called Optical Coating Laboratory [Incorporated], OCLI. The president was Rolf [F.] Illsley. So, I went back to Norwalk, called up OCLI, and stated, “I'm interested in your circular variable filter. Is there somebody there who could talk to me about it?” They declared, “Yes! That's our president—Rolf Illsley. This is his pet project.” So Rolf picked up the telephone. I told him what I thought about it and he replied, “Well, you couldn't have hit me at a better time because Beckman has backed out of the project. They don't think they can make any use of it and we've got to figure out something.” He continued, “Come out and visit.”

So I flew out to San Francisco. As I arrived at the airport, I was paged. I pick up the phone and was told, “Mr. Illsley is waiting for you in the commercial aviation section.” Well, he had his own plane and had flown down to pick me up. Illsley flew me up to Santa Rosa, which is 100 miles or so north of San Francisco, to their plant. We had a great visit and I finally ended up saying that we would buy up all of the Beckman filters that they'd made—we'd buy them from Beckman and then he'd make more for us, but we'd change the design a little bit. So I came back, Tony and I looked at it, and we thought, “What are we going to do with this filter?” Well, this was right at the time when emissions analyzers for gasoline engines became popular. You know, analysis for CH, NOXs, carbon monoxide, and that sort of thing, which you could do very nicely by infrared because they all have characteristic absorption bands. Tony developed a long path gas cell that was somewhat similar to the White cell—John White had developed one several years before while he was at Perkin-Elmer, but John's had some faults. It was very difficult to change the path length. But Tony had a very clever design where you could rotate a mirror and convert it from a meter path length up to 20 meters by simply turning a dial. Our object was to sell the CVF instrument with the long path gas cell to the emissions people in New Jersey and wherever else they were setting up emission centers.

By the time the instrument came out, we were too late. Other people had come along with gas analyzers and captured the market. However, OSHA [Occupational Safety and Health Administration] had just come into existence, and the world was very concerned about toxic vapors in the workspace and the atmosphere. All of a sudden our instrument, because it could be set up to measure any gas, was just the one that was needed. We had walked into this market without realizing it. It's a kluge of an instrument, but probably at least ten thousand of those instruments were sold and are still being used today. Nothing has really taken their place, although there will be an instrument that will.

That led Wilks Scientific into a totally different business. Instead of being an accessory manufacturer, we became an instrument company. I became interested in interference filters because there is so much that you can do with them. My interest has always been to find practical applications for infrared. We learned that we could develop an application for a FT-IR or a prism instrument that would pick out an absorption band that could be used to control the process. Well, you don't need an infrared spectrometer to do that. All you need is a filter instrument, a filtrometer, which is what we started making at Wilks Scientific. We developed two instruments: one, a gas analyzer; the other, an infrared probe that had an optical element we could stick into a beaker and analyze what was in the beaker. For various reasons that never got to be very successful, but the gas analyzer was tremendously successful.

I have to tell you a little Perkin-Elmer/Beckman story. Wilks Scientific created the Model 9 ATR attachment, which I loaned to Bob [Robert] Hannah in the application laboratory at Perkin-Elmer. Three months later I went to a spectroscopy meeting in Chicago and one of my friends said, "You've got to go into the Perkin-Elmer booth." I went into the Perkin-Elmer booth and there was a carbon copy of our instrument with a Perkin-Elmer label on it. Same mirrors, same everything. I got upset at this. So when I got back to Norwalk, I called up Chester [W.] Nimitz, Jr., the then president of Perkin-Elmer, and declared, "Chester, I'd like to come and visit you." He replied, "All right, Paul. Anytime."

So, one snowy afternoon, I drove up to Perkin-Elmer, which was about 10 miles north of us. I took my instrument and one of the Perkin-Elmer instruments that I had purchased. I went into Chester's office and set both instruments down on the table and inquired, "Chester, why did you copy this? I loaned it to you so that you could test it. We would be glad to make it for you and put on your own label and that sort of thing." He looked at me and replied, "I'm going to build this company 20 percent a year. You don't have a patent on that, do you?" I answered, "No," and he retorted, "Well, I'm going to copy, steal—I'm going to build this company. You'd better patent anything you develop."

Two or three years later, we created a twenty-meter gas cell. Beckman came to us and asked, "Can you adapt this to fit into an infrared spectrometer?" We worked on it, and adapted the instrument. There is a wonderful book that was published on OSHA compliance testing using an infrared spectrometer and the twenty-meter gas cell, which we made for them (3). Perkin-Elmer came to us and inquired, "Can you put it in our Model 21?" We responded, "Yes, we can do the optics and so forth." After we had been delivering the instruments to Perkin-Elmer for about six months, a Perkin-Elmer purchasing agent called me up and asked, "Paul, how come you sell the same cell to Beckman for 90 percent of what you sell them to Perkin-Elmer?" I stated, "This is the way we're getting back at you guys for copying our instrument!" [laughter] Literally, we charged Perkin-Elmer 10 percent more for years. There's <u>always</u> a way to get back at somebody! [laughter] That cell led Wilks Scientific into gas analysis and we designed a lot of similar instruments that were portable, easy to carry, dedicated instruments. If you wanted a versatile instrument, you got the MIRAN 1A [miniature infrared analyzer].

The company grew very rapidly. We were growing faster than we could generate cash to support our growth. I remember we sold forty-percent interest in the company to EG&G [Edgerton, Germeshausen, and Grier, Inc.]. I made a deal with them that two years down the road—one or the other could offer to buy the remaining interest in the company—if EG&G made an offer to buy the 60 percent that we still owned, we would buy back the 40 percent at the same price. We would have six months to raise the money to do it. After a couple of years, we said to them, "We'd like to buy back the forty-percent interest. Make us an offer for the 60 percent."

We had a big pool in the office. They had thirty days to come up with a price. And we were betting, "What are they going to offer for us?" Well, it turned out that they offered us half of what anyone in the company thought the company was worth. So we had six months to come up with the money to buy back EG&G's interest. We found a company, International Nickel [Company]. International Nickel was trying to expand into high tech business—they paid twice as much as EG&G had offered for the forty-percent interest in the company, so we bought back EG&G's interest, sold the 40 percent to International Nickel, and had some working capital left over.

A few years later we reached the point where we were still capital tight and we couldn't go public because this was in the mid-1970s and the stock market was terrible. There was tremendous inflation and no market for new issues. Bendix [Aviation Corporation] came after us. Bendix wanted to buy us in order to fit us in with one of their groups in West Virginia that was involved with infrared. I almost sold the company to Bendix, but Foxboro [Company] heard that we were available.

I remember that I was in Holland with my son [Donald K. Wilks]. He was working in our English facility at that time when I met him in Amsterdam. We were sitting in a Holiday Inn when I got a telephone call from John Dobson, the vice president of Foxboro. Dobson declared, "Paul, don't sell to Bendix. We really want you!" [laughter] So, I held off the Bendix deal and listened to what Foxboro had to offer. Foxboro made process control instruments that controlled environmental variables—basically temperature, pressure, and flow. That's all they did and John's attitude was, "We need new analytical technologies. We need infrared, we need gas chromatography, and we need conductivity." So, he went out and bought a conductivity company, an infrared company—which was us—and a GC company, which were going to operate as satellites to the main company. He told us, "Go on doing your own thing, but we'll use your technology to expand our process control applications."

Well, it worked fine until Chuck [Charles] McKay was put in charge of those satellite companies. McKay was of the attitude that he was going to build another Foxboro. He was going to bring all those companies under one roof and combine them. That was the kiss of death as far as I was concerned, because I didn't want to be part of Foxboro. I was very happy to run my little segment of Foxboro down in Norwalk. So, that led me out of Foxboro. [laughter]

DAEMMRICH: May we pause and go back to Wilks Scientific prior to the Foxboro deal? Who were your customers?

WILKS: We were selling to the chemical processing industry. That was our big market.

DAEMMRICH: In terms of OSHA and the new environmental market, how did you track that trend? Did you see that market emerging?

WILKS: It came to us in the sense that all of a sudden OSHA was concerned about the air in workplaces and we recognized that we had the kind of instruments that could be used to monitor gases in ambient air. I remember going down to a Cyanamid subsidiary in New Jersey. They wanted to measure the amount of ethylene chloride in the atmosphere. That was the first time that we ever tried using our instrument, and we discovered that it worked very well. We put it in a corridor and waved the wand around to figure out the concentration of ethylene chloride in different areas. We figured out that the worst places to be in this corridor were the alcoves where people were stationed at desks. Even though they had fans blowing out in the middle of the corridor, the alcoves had high concentrations of gas. Well, that's the kind of thing you learn from a portable instrument. We began to realize that this was a very good potential market, so we advertised and exhibited at shows.

I went to a meeting in Washington. It wasn't ethylene chloride there, but rather vinyl chloride that they were most interested in. Do you remember there was a big scare about vinyl chloride? There was a group of men—most of whom had cancer—who had worked in a vinyl chloride plant in Cincinnati for ten years. Well, that's what really tipped off OSHA to develop regulations about vinyl chloride.

The meeting in Washington was put on by the [United States] Department of Labor. They were trying to establish limits for vinyl chloride in the atmosphere. They knew I came from an instrument company so they pointed at me out in the audience and asked me to stand up. They said, "You make an instrument that can measure ambient air. How low can you measure vinyl chloride in the atmosphere?" Without thinking, I replied, "We can probably get down to a part per million." They said, "That's the level" and immediately they set it at 1 part per million, because it was feasible to measure that. Not because it made any sense—the Cincinnati group was exposed to 10,000 parts per million day after day. Anyway they established this ridiculously low level—well, we sold a lot of instruments to the vinyl chloride industry because we had the only instrument that would measure down to the OSHA limit.

DAEMMRICH: So in a sense, since OSHA didn't have the health and safety data, they went to the measurement level?

WILKS: Yes. The typical reaction was, "How low can you measure it?" They still do this today. Arsenic in water, for example—parts per billion. You can stand a higher level of arsenic, but because we have techniques that'll measure that low, that's where the limit was set, without any real scientific study of what's harmful and what isn't. But, we made a lot of money on it, so I can't complain. Yet, it really bothered me that they made these decisions based on a lack of scientific or medical history.

BROCK: When did this take place?

WILKS: This was in the early 1970s. Our instrument, the MIRAN, came out in 1971. It was in the 1970s that the OSHA business expanded. We expanded, but we ran out of capital because we expanded too fast and that's what led us to sell out to Foxboro.

BROCK: Was OSHA, in that same time period, doing what the EPA [Environmental Protection Agency] was doing: defining analytical methods? Was OSHA making statements like, "If you're going to analyze water, use GCMS [gas chromatography mass spectroscopy]," etcetera?

WILKS: No. OSHA just wanted equipment to measure specific chemicals. Lately, I've worked a lot with the EPA and they're totally different. They define methods, "This is the way you're going to make the measurement." At OSHA, the attitude was, "This is the limit we set and now you've got to find a piece of equipment that'll measure that limit." So, that takes me through Wilks Scientific, which of all of my companies was probably my favorite. [laughter]

DAEMMRICH: How many employees did you have?

WILKS: At that time, we had two hundred twenty odd employees. Now, the reason for this was because we couldn't farm out our manufacturing. There were not, in our neighborhood or anywhere, the kinds of optical shops that we needed to do infrared optics or electronic assembly; there weren't even machine shops, so we had to have, within Wilks Scientific, all the resources to build our products. Today, it's totally different because—especially in our part of Fairfield County—there are optical shops that do beautiful work on infrared optics, there are machine shops, and there are circuit design people. My next company, GAC [General Analysis Corporation], got up to the same volume with sixty people instead of two hundred twenty people because we farmed everything out. But at Wilks Scientific, we had a large number of employees because we had to do it all ourselves.

DAEMMRICH: How did you act as manager? Were you focused on your product development? Were you focused on marketing and sales?

WILKS: Combined. My prime interest was and is in recognizing an opportunity in the marketplace that can use my technology, so I really concentrate on the issue of where we can apply infrared spectroscopy in the marketplace. What has happened in infrared over the years is that other programs, like the space program, have developed new infrared detectors and new infrared materials. That lets us instrument people apply them to what I call "real world" problems like OSHA, solving problems in the chemical industry, or whatever. We're constantly able to make use of infrared in smaller and less expensive devices that are more sensitive. This is the way the world turns. Today we're getting the same kind of help from the computer industry. We get these little chips. I've got a whole infrared spectrometer right here with just microelectronics in it.

Anyway, when Chuck McKay began to gather all those satellite companies together in Foxboro, I said, "This is not me. I don't want to be part of a big organization."

DAEMMRICH: Let me ask the same question a little differently. How would you characterize your management style at Wilks?

WILKS: My management style was to try to have the best people that I could take responsibility for various aspects of the business. Take for example, Tony Gilby, who was our chief engineer. I had a good production team, and then I had people who worked in the laboratory. I'm very weak in financial management. We're always way ahead of the resources we have, but I try to develop a team of people who will be able to plan our growth. The company—the manufacturing side—worked pretty well.

I spent most of my time looking for new markets for our existing products or looking for markets where we could develop a new product to fill that market. Some of the people that worked for me at Wilks Scientific came along to General Analysis, and some of them are with me today—one of them was from Wilks Scientific, another from GAC—and we're beginning to take on people from other companies that I've worked with. My management skills are marketing and applying technology to the marketplace.

So, we have one more company to go through.

When I was at Perkin-Elmer, I was in charge of the first exhibit that was ever put on. It was in Grand Central Palace, the exhibit hall next to Grand Central Station [Terminal] in New York. It was a chemical industry exhibition. I was all by myself setting up the booth. We had a Model 12 mounted in a cabinet along with a recorder and amplifier. I remember a rather stocky, tall, bald individual standing in the background watching me. He continued to watch me until I got the booth set up, then he approached me and declared, "I'm Arnold [O.] Beckman. I know who you are. You're from Perkin-Elmer. We're building an infrared activity on the West Coast and I'd like you to consider coming out and joining us." I liken this situation to a Yale [University] man approaching a Harvard man! I was very flattered, but finally told him, "No, I don't think I want to do this." I went back to Perkin-Elmer and told Van what had happened, and Van replied, "They're trying to build their business. If you want to go, go. Do you want to live in California?" I said, "No, I'd rather stay in Connecticut." But I was very pleased that that very nice gentleman knew who I was. Anyway, I saw him a number of times after that.

DAEMMRICH: Previously, you stated that you visited with your son in Amsterdam. Did you take Wilks Scientific international?

WILKS: Yes. We had a facility in Milton Keynes, which was a growing area in England at that time. My son had gone through a divorce situation and was looking for a job, so I hired him. He went over there and helped set up that facility because we did some manufacturing there. My interest in going to England was that the British have a lot of good ideas and you can often hear good ideas from them, but they're lousy at running, building, and marketing a company. So I thought that if we had a facility in England, it would help us. Besides we had a lot of business there at the time. We had quite a successful operation in Milton Keynes, with Don working there.

DAEMMRICH: Now, of course, environmental and health regulations in England are clearly different.

WILKS: Actually, they're very similar in England. They had a very similar organization to OSHA. We were building and doing final assembly on MIRAN analyzers in England because we could get inside the customs barrier by shipping over partially assembled equipment. We were doing a good business in England and elsewhere in Europe. So it made sense to have a facility there. We always had a good export business in all of my companies and I used to travel a great deal to Europe selling accessories and instruments.

I left Foxboro and had the idea that since there was so much interest in occupational environment monitoring that we should set up a company doing that service, and, in fact, Don came with me too. He left Foxboro at about the same time and I talked him into setting up a facility to equip vans with instrumentation. I went to Foxboro and made a deal with them that I could buy MIRAN analyzers from them in order to build a business offering services in workspace monitoring. This was about the time Ronald [W.] Reagan became president. Reagan put clamps on occupational health, which killed the business.

While I was with Foxboro, just before I left, I became interested in applying a new type of internal reflection optical element, which was something that I came up with—a cylinder that we could reflect energy down through, surround with liquid, and use as a measuring tool. I also got interested in the beverage industry. They needed to measure sugar and water, and carbon dioxide [CO_2] and water, which was something that we could do with this kind of an approach. These are the two principal things you measure when measuring Coca-Cola, Pepsi Cola, or whatever. We actually started a program at Foxboro, but when I left Foxboro I forgot all about it while we were trying to do the occupational health thing. Then I went back and decided that maybe there was real potential there because the beverage industry really needed an instrument that would monitor the quality of their product.

We developed a process monitor based on circular internal reflection, which is a sensing tool. Don did a lot of the design work on it and I came up with some optical concepts that were quite different from what we had ever used before. A very interesting sidelight was that when I was at Wilks Scientific, I applied for a patent on the circular internal reflection optical element. We didn't have any money when the first stage of the patent came back and, as always, everything had been knocked down, so we couldn't support a fight for our original plans. Don, my son, who was never happy about patents, said, "They're a waste of time; people can copy them." So we just let it die.

A patent was issued covering a variable path length scheme that we'd put into the original patent, but they wouldn't give us the basic concept of circular internal reflection. So when we started developing an instrument at GAC using circular internal reflection, I got a very nice letter from Foxboro stating, "You're infringing on our patent." I wrote back, "Please read the patent carefully because you will find that it doesn't cover circular internal reflection at all."

[END OF TAPE, SIDE 3]

WILKS: We didn't have enough money to pursue the patent, but I think we could have gotten a basic patent on it. Jim Harrick said it wouldn't work. He republished an article in *Applied Spectroscopy* stating, "I can prove mathematically that a circular internal reflection rod won't function (4)." Well, it did function because it worked for us. My approach has always been what I call "empirical optics." My son is a fundamentalist. He has to do all the ray tracing and that sort of thing. My idea was that you could just throw some energy in on this side and if it comes out on that side and you get some reflection in between, it's going to work. I don't quite know how the rays actually trace their way through, but it does work.

Anyway, we decided to build a beverage analyzer which took us more than two years. We installed two or three at PepsiCo [Inc.] plants, but they didn't function for various reasons. The crystals became coated and we had interference between CO_2 and [sugar] bricks. When we finally figured out a solution to those problems, we went to Coca-Cola [Company]. Pepsi had gotten tired of testing our instrument, but Coke accepted the improved product. Eventually Pepsi did as well. In the next several years, we equipped most of the big beverage lines in the world. We probably put out close to two thousand of those beverage analyzers, half of them in the United States and half outside.

Then, I hit seventy and my wife decided it was time for me to retire. The company was going well. We were doing about eight million dollars in business, although it was in somewhat of a slump because the beverage industry was down and I had spent a lot of time trying to find other markets for the same basic instrument. I decided that someone should take over GAC, so I gave Don the opportunity. I'm not sure he really wanted the job, but I gave it to him. That turned out to be a mistake because although he was a top-notch engineer, he was not a good manager and had no market sense. I kept telling him, "You've got to find other markets for this technology." He just wanted to design a new instrument. He spent all of his time doing that and the company got into real financial problems. In the meantime, I decided to go out on my own again. I took a filter instrument that we had partially designed at GAC to the board of directors who said, “Fine, if you want to go ahead and do something with it, you can have it. We’re not going to take it anywhere.”

That formed the basis of the company that I now have [Wilks Enterprise, Inc.]. We finally ended up selling GAC to OI [Corporation], which is in Texas. OI took over GAC and moved the operation to College Station, Texas. No one from GAC moved with the company, which caused a big problem. This is what happens when a big company buys a smaller company. The big company thinks that they can move the smaller company anywhere and that it will remain in intact, but if they don’t get the people to move, then they have nothing. They have designs and a product, but they don’t have the people who know how to make it cook.

Anyway, Don has gone to work for Don Sting at SensIR [Technologies]. My son is the one who designed the product [Travel-IR] that is going terrific for SensIR. It’s a portable microscope FT-IR, that is good at identifying white powder, and boy, as soon as 9/11 [11 September 2001] came, an instrument that identifies a white powder—is it sugar or salt or is it anthrax or is it a drug—was suddenly in high demand. They’re making these instruments, a seventy or eighty thousand-dollar instrument, as fast as they can. Basically it was Don’s design, so I’m very glad to see him in a position where he’s doing the kind of work he knows how to do. Don went to Harvard and majored in economics, but took spectroscopy on the side!

That leads us to Wilks Enterprise. Our business started out with us trying to build a fat analyzer. We wanted to measure fat in hamburger and the like, using ATR, but that turned out not to be a good application. The main reason was that if you put hamburger on an ATR plate and try to measure the fat, the fat comes out and sticks to the plate, so you can’t pick up the protein. It was not a good application. In the meantime, the EPA came along. We worked with the EPA to try to develop a method of measuring total petroleum hydrocarbon, TPH, and total oil and grease, TOG. These are the things that you measure in water. This traditionally had been done using a Wilks MIRAN analyzer with freon as the solvent. You mix up freon and water and extract the hydrocarbon. Freon is transparent in the CH region, so you can stick it in a cuvette and measure the hydrocarbon content with a filter instrument like the MIRAN.

At Wilks Scientific, we developed a portable analyzer that did just that. It’s in use today on many of the platforms in the Gulf of Mexico. The EPA approached Wilks Enterprise and asked, “Can’t you develop another sampling approach because we have to do something to replace freon?” We eventually came up with a horizontal ATR plate and the solvent used is hexane, which works just as well as freon to extract hydrocarbons from water. But you have to get rid of the hexane because it’s a hydrocarbon and absorbs at the same wavelength as the oils that you’re trying to reach. By using this horizontal platform and putting a sample of hexane on top of it and letting it evaporate, we measure the residual hydrocarbon. That’s the procedure that’s gradually taking over today and we’re beginning to sell a fair quantity of these instruments to replace the old Wilks MIRAN instruments that are out there. People love them, but they don’t make them anymore. Foxboro went out of the business and the instruments are getting corroded and so forth. Basically, that’s one of the applications for this device—we found that we could replace the fat application as well.

Recently I have been interested in trying to make in-line sensors based on IR—everybody's looking for sensors today. Nobody has a good mid-infrared sensor and the mid-infrared is where the information is. I've been working for the last three or four years, gradually moving toward the ability to put these little plugs in streams. It turns out that one of the big applications is carbon dioxide in water. Infrared is the only known method of measuring dissolved CO_2 *in situ* without going through some kind of a mechanical extraction stage. That was one of the real reasons that the GAC LAN systems—LAN meaning liquid analyzer—were so well received because the competing technology is either refractive index or density.

The problem is that a fluid has only one refractive index or one density, yet carbon dioxide and sugar both contribute to the refractive index or to the density, so you have to have some other method of separating the two. There is a pressure temperature method for measuring CO_2, or a diaphragm method, that one then has to correct the refractive index and the density. Infrared has individual absorption bands for each component. You measure the absorption band for sugar and CO_2 on the same sample. That was the principle of the GAC instrument. Applying the GAC instrument required that you take a sample off the line and pass it through an absorption cell before it goes back on-line and this was always a problem because of potential contamination.

The beer industry won't use that kind of instrument because they don't want to see microbes getting back into the process. Microbes can upset the whole situation. I've been working on actually making the measurements on-line. It's the same old story: new electronic devices become available mostly because of the communications field. There's a tremendous explosion of microelectronics. You can make things smaller and use little chips to do processes that vacuum tubes used to do when I first started doing business and transistors did later on. But now microprocessors are in. I'm going to be building in-line infrared sensors. To me that's the future of our business. The filter instruments are going very well. They're portable instruments. You can put them alongside the process, take a sample off, and analyze it. They're an intermediate step. Instead of taking the FT-IR instrument out of the laboratory and into the plant—you can't really do that because it won't operate in that environment—we can take a filter instrument that'll do the job that the FT-IR instrument does. The real ultimate step is to take IR right onto the process line itself with the IR sensor.

I went to a meeting in Atlanta last week for InterBev, the annual exhibition and conference for the international beverage industry. At that meeting there were applications for CO_2 analysis that I've known about for a long time, but they're here today. There isn't any other way of doing it except by infrared. This sensor is going into breweries because in breweries there are at least five different places in the beer process where they need to monitor CO_2—in the fermentation tank, in what they call the "bright product tank," which is the finished beer that creates its own CO_2, but they have to continually monitor the CO_2 level.

Before high-gravity beer, which is 12 percent alcohol, is packaged, it is blended with carbonated water to bring down the alcohol content to 3.2 percent—that's the beer we drink. The reason it's 12 percent is that's as high as you can go in the alcohol content without killing the microbes. It's the same with wine. Beer is blended down with carbonated water, so they need to measure the CO_2 level in the carbonated water and the CO_2 level in the beer. There's no process that'll do it for them today except taking a sample out and doing a pressure temperature test on it, but this device is going to do that.

There are two other places where this instrument is really going to have an impact—if we can get the cost down—the soda dispensers that you see in McDonald's [Corporation] and at stopovers on the turnpike, where you go up with your cup, put some ice in it, and add the beverage. The biggest problem is monitoring the CO_2 level because if the CO_2 level drops, no matter how good the syrup is that they mix with the water, people don't like it because the soda tastes flat. So, this market just sits there and there are literally millions of these dispensers. I talked with people at shows and they have told me that if I could build a CO_2 sensor that could plug right into the line and could produce it for under one thousand dollars, that I've got a market. I know how to do it. That's what we're going to be moving toward.

Another one, and I've known about this for a long time too, is that Coca-Cola has white trucks that say "quality" on them. Those trucks go around and check the beverage that's being dispensed from McDonald's. They desperately want an instrument that they can stick into a glass of Coca-Cola that's been dispensed and measure the CO_2 level. They don't care about the sugar level. They want to be sure that the CO_2 level is right. I talked to a man yesterday and he's been looking all over the world for an instrument like that. I said, "I know how to do this. In fact, I have a patent on the design!" [laughter] Now, I've got to figure out how to raise enough capital to do the design work and that sort of thing. So, two very mass-market applications for infrared technology in measuring CO_2 have come out of this show.

The big problem in hydraulic systems is water in the hydraulic fluid. We have been able to measure water down to the thousand parts per million level, a tenth of a percent water. This is a technique, which—it doesn't work optically, but what we need to get low concentrations is to have a longer path. Water's a strong absorber. We can't use a long path when we're measuring something in water, but if we're measuring water in a solvent or a fluid such as hydraulic fluid, it doesn't absorb infrared where water absorbs. I figured out that if we put a saw cut through the crystal on the sensor—normally the beam goes from this surface to that surface to this surface, and then it goes to a detector, but if we put a saw cut in here, we now have basically a transmission cell. I've expanded the path length to where we can measure water down to less than 100 ppm. We are going to call the technique "trans/ATR" because it combines both measuring methods.

My son has looked at it and said, "It's not going to work, Dad, optically, because the rays are not going to pass through the slot." Well, they do. One of the reasons is that when you dump this in a fluid, the index of the refraction of the fluid is close to the index of the refraction of the crystal itself so that the reflection losses from surface to surface are much less. I found that putting that simple saw cut in gives me about a fifteen times increase in sensitivity and we can now measure down in the hundred parts per million level of water in hydraulic fluid.

It turns out that the European automobile market has been desperately looking for an in-line sensor that will measure water in brake fluid and transmission fluid. The reason is that a little bit of water in transmission fluid creates a very corrosive situation because of the additives in the brake fluid. The water and the additives get together and create sulfuric and nitric acid. This happens especially if there are aluminum components in the stream—if there are, they get pitted and it's a very bad situation. So here's a market that's sitting out there.

We have the technology—here's the market—how can we put this together and come up with a product cheap enough so that we can get to these two mass-markets? One is the beverage industry and the other is the automotive industry. Well, this is what business is and this is what I've been doing forever, it seems. [laughter] It fascinates me that these applications are solvable.

Now we have a relationship with Perkin-Elmer. They're willing to develop these microelectronics and they're really looking for mass markets. They have a Chinese production facility and their attitude is that if you can come up with something with a big enough market, they can get the cost down and produce it in quantity. Anyway, this is where we're heading with my company right now. I hope I can stay around long enough to get this off the ground because to me this is the ultimate in infrared. You start off with laboratory devices, which only work in air conditioned rooms, rock-salt prisms, and that sort of thing. Then way out here we've got these little plugs that we can do the same thing with. It's the same technology, but a totally different approach.

Anyway, that's where my company has reached at this stage of its development. We have one other project that we're working on now. When Foxboro sold the MIRAN business to Thermo [Electron Corporation], Thermo decided to cancel out all of the ancillary products except for the big, semi-portable, variable-wavelength, microprocess, gas analyzer called the SapphIRe. It's really called the MIRAN SapphIRe, which was developed at Foxboro. It's a great instrument, but it's in the twenty thousand-dollar range and weighs 50 pounds—it's not all that portable.

The people who used to sell the MIRAN dedicated gas analyzer—a smaller version—came to us and said, "We need these instruments which are not being made anymore. We'll put up the money if you redevelop these instruments." It was like reinventing the wheel. We're going back into the same market where Wilks Scientific was, simply because Foxboro and Thermo have decided to abandon that market.

I have a contract with the Royal Navy to develop replacements for refrigerant gas analyzers. The Navy has to monitor the air quality in submarines and they can't buy the instruments anymore from Foxboro, so they approached us. We're kind of reinventing the wheel, but that's where Wilks Enterprise is today. We're back in the beverage business, we're back in the ambient air monitoring business, and we're looking at in-line sensing.

BROCK: Are the sensors a continuation of the reflectance technology?

WILKS: Yes.

BROCK: Are these non-dispersive gas analyzers then?

WILKS: They're selective wavelength. You know, NDIR [non-dispersive infrared] is a misnomer. The term non-dispersive is used incorrectly. A non-dispersive instrument was developed by Luft in Germany to look at all wavelengths all the time. You have two cells, one which is full of what you want to measure and absorbs all the wavelengths that you want to measure, and the other is your sample cell, to compare the absorbance. Most non-dispersive instruments were made by Luft and Mine Safety Appliance Company [MSA].

What we make are selective wavelength instruments. These are instruments that select a specific wavelength and measure that wavelength. They use the same filters and electronics as liquid analyzers, but have a long path length. That's the gas analyzer. Actually there's a cell that we're going to buy from a company on the West Coast that has developed a nice long path gas cell. We can put our electronics and detectors with it. In a sense we're going back and redoing what we once did, but we're doing it with modern microelectronics and microprocessors, which didn't exist when we designed the MIRAN system. Anyway, that's Wilks up to date.

I want to go back to another instance of communication between DuPont and myself. I had a telephone call one day from a friend at DuPont who said that they had thirty-two FT-IR instruments by four different manufacturers in their organization and the different makes wouldn't talk to each other, which created problems when trying to transmit spectral data. This got me thinking and I got in touch with a friend at JCamp [Joint Committee on Atomic and Molecular Physical Data] who was interested in disseminating information of this sort. They agreed to sponsor a committee to try to find a way to communicate among the various companies. I was able to get representatives from each of the instrument manufacturers to attend a meeting at Pittcon where we decided that this was something that was needed.

We went to work and through the efforts of Bob [Robert S.] McDonald, a retired spectroscopist from General Electric and others, we, collectively, developed a program, which is still being used today, called JCamp-DX. It is a way that spectra can be digitized and distributed to any FT-IR system and disseminated so that all these different instruments can talk to each other. Apparently it's still in use. It's on the Web [http://www.jcamp.org] and a lot of the spectra that are available from NIST [National Institute of Science and Technology, formerly Bureau of Standards] and from the other organizations are in JCamp-DX format, so that they can be easily transmitted.

BROCK: When did computers and IR's become conjoined?

WILKS: That came about because of the development of FT-IR. You need a computer to convert an interferogram to a spectrum. It really takes a computer program to be able to do that. Once you have a computer you can do lots of other things with it, so that's how the infrared technology became totally computer-oriented. Once computers became available, then the various companies that sell spectra put them all on computers so that you can easily download spectra today. It makes it much more convenient to work in the infrared region. The same is happening in mass spectroscopy also. All the various spectra available are computerized.

BROCK: Interesting. Going back in time to when you first joined Perkin-Elmer, you mentioned that John White joined the firm the same day that you did. Could you tell us a little bit more about John White and his role at Perkin-Elmer?

WILKS: John was a spectroscopist at Esso in Linden, New Jersey, which is now Exxon. He had become very much interested in infrared spectroscopy. I'm not quite sure how he came about being hired by Dick Perkin, but he did come from Esso and was very happy to make the transition. John became a very important part of the company. He developed the so-called "White cell," which was the first long path absorption cell with a 20 meter effective path length, and fit into a Model 21. One could look at very low concentrations of gases with that sort of a cell. John did the optics for the Model 21 among other things.

BROCK: When you came to Perkin-Elmer, what were the sizes of the different groups?

WILKS: When I joined Perkin-Elmer, it had about sixty employees, most of whom were primarily opticians. The big activity of the company was making components for tank sights and mirrors for large telescopes. They did have an affiliation with a group on Long Island that was doing the optical design of telescopes and telephoto camera lenses. I think they were an independent group that was working mostly for Perkin-Elmer at that time, but then they merged into Perkin-Elmer when it moved from Glenbrook—they had a relatively small plant in Glenbrook, Connecticut—to Norwalk, on the Norwalk/Wilton border.

[END OF TAPE, SIDE 4]

WILKS: The optical business slacked off at the end of the War, but the instrument activity picked up and became the major activity of the company.

BROCK: When you joined, who was heading up the IR effort?

WILKS: It was run mostly by Dick [Richard F.] Kinnaird [Sr.], who was a mechanical designer, and [Lloyd] McCarthy, Dick Perkin's brother-in-law. They were engineers and had no marketing affiliation or anything of that sort. The instrument business grew because all of a sudden Perkin-Elmer discovered they had a bear by the tail, really. They were getting so many orders for their instruments.

We learned later that this was due to two programs. One was the synthetic rubber program which measured the butadiene ratio beautifully by means of infrared. The other was the atomic bomb program, in which infrared was a very important tool.

We dealt with a purchasing group in New York City. All we knew about them was that they had very high priority. Every time they called up and wanted an instrument, they got the next one off the assembly line. It turned out that they were the purchasing group for the Atomic Energy Project. When the first bomb was dropped, the purchasing agent called me up and said, "Now you know what's happening to your instruments." He really called to thank us for our efforts. That's why infrared got such an impetus during the War—those two programs.

BROCK: When did Van Zandt Williams come on board?

WILKS: He came on around 1949. He came on to supervise the infrared activity of the company.

BROCK: Could you say a little bit more about him as a person and his contribution?

WILKS: He was an extremely likable person and had a very pleasant personality. Everybody liked Van. He was not tremendously forceful. He was not the kind of person that would set goals and say, "We're going to do this. We're going to do that." From a scientific standpoint, he was tremendous in infrared and interested in the field. That was his main contribution. He felt that it was a tremendously important technology and anything that Perkin-Elmer could do to move infrared forward and make it more widely used was important.

Van was instrumental in getting the Coblentz Society started because he felt that there needed to be a strong group that would make sure that the infrared work that was being done was of the highest possible quality. That meant having high quality spectra available and making sure instruments were properly used. It was possible that if you set the controls wrong in a spectrometer like the Model 21, you could get spurious absorption bands. Van was very conscious that people should use the instruments properly so that they didn't get false information.

BROCK: We talked before about how there was this unanticipated demand for the Model 12. When and how did the idea emerge to start developing a double-beam instrument, the Model 21?

WILKS: That developed because of the work that was done at Dow Chemical, in Norman Wright's group. When he publicized what he was doing, the IR instrument companies—all three of them: Perkin-Elmer, Beckman, and Baird—immediately descended on Dow. Dow freely gave up the information. They were not an instrument company. Dow just wanted an improvement in the instrumentation that was available for them to use.

Baird, literally, copied the exact model that Dow had developed. It was a big instrument with a large rock-salt prism, quite cumbersome. Perkin-Elmer and Beckman redesigned existing instruments that they already had. Beckman had the IR-2 and Perkin-Elmer had the Model 12. The 21 was a redesign of the 12. It had the same basic monochromator, but had a double-beam front end. It used the same parabola and the rock-salt prisms that were used in the Model 12. Beckman's instrument was the IR-4. Now Beckman also had another instrument that was a memory instrument. In other words, you ran a spectrum and recorded it on a tape, so that when you ran an analytical spectrum after that, you ran it against the tape. That is precisely what is done today with an FT-IR instrument, which was before its time because it was very difficult to synchronize the tape. Beckman had given up on the IR-3 and went to a straight double-beam instrument like the Perkin-Elmer.

BROCK: What was your role in developing the double-beam instrument?

WILKS: I had moved into sales and marketing. Vince Coates and I assembled the first instruments because I knew how to put the monochromator optics together. I'll tell you a very interesting story about the Model 21. John White came out one day and watched me assembling the Model 12. It turned out that I was the only one in the company that could adjust the slit mechanism so that it would function properly. He watched me for a while and noted, "You're left-handed." I replied, "I'm left-handed, that's right. That's why I can do this." He went back to his desk and turned his drawings upside down and reversed the flow in the Model 21. If you look at the Model 21 today, the monochromator is on the left and is accessible by your right hand, whereas the Model 12 monochromator is on the right and is accessible by your left hand! So that's why the two instruments are reversed. He had started designing them so that they were carbon copies of each other.

BROCK: Who were the other key people, as you saw it, in developing the 21?

WILKS: Well, the basic work was done by John White and Max Liston. Max developed the electronic side of it. He'd already developed a high-speed thermocouple that was used in the

Model 12. John White did the optical design and the mechanical layout. Vince Coates was the principal mechanical designer. He did most of the drawings that were necessary to put the Model 21 together. Then he and I together assembled the first instrument and figured out why certain parts didn't fit. [laughter] That's always the case with a new instrument.

BROCK: During this time period, when you were involved in advertising and sales, you were mostly visiting chemical process firms. Were you meeting with the analytical research chemists in those firms?

WILKS: At that time, most chemical companies had instrument groups, whom we dealt with primarily. They were typically in analytical departments or segments of research departments where the basic instruments were kept. These were the people that we talked with mostly. It wasn't until the lower priced, simpler instruments came along that they really spread out and went to the chemists. All three companies participated in infrared schools that were held at MIT, Fisk University, and the University of Minnesota. These were annual affairs where the instrument companies brought their equipment and taught people how to use them. That was a very major activity.

DAEMMRICH: During 1947 through the early 1950s, to what extent did you meet with customers in order to tweak the instruments for their needs?

WILKS: Well, we didn't carry the instruments around with us! [laughter] They were too heavy. We'd try to get people to come and visit us. We put on displays at schools that attracted prospective spectroscopists and we supported universities, so that's where a lot of the education took place. But, we mostly visited and discussed applications with people. There was always a choice, "Should I buy a single-beam or a double-beam instrument?" We tried to find out what their basic applications were going to be, then push them in the direction that we thought was best for that particular situation.

BROCK: Thinking of IR up until 1957, were there important lead users or lead sites that you were particularly interested in maintaining a connection with?

WILKS: Yes, definitely. Of course we were interested in staying connected to the big chemical companies: DuPont, Dow, Esso, Monsanto [Company], and Shell. Shell was primarily a Beckman company. All of the major chemical companies were very prime targets as far as we were concerned. But, to us, DuPont was the leader. They were really ahead of most of the other companies in their use of infrared. They had a group that met once a month and discussed infrared applications and we were invited, periodically, to come and talk to them if we had some new development that they wanted to hear about. We also used them as guinea pigs. If we had something new, we'd let them try it. If they liked it, we figured the rest of the industry would like it also.

BROCK: Did the IR market divide into camps—Shell as a Beckman lead user site; DuPont as a Perkin-Elmer? Could you talk about the different IR competitors in this period?

WILKS: Well, Baird sort of dropped out of it. They were the first that backed away from infrared, although they were very active in mass spectroscopy. Beckman, of course, was strong in the ultraviolet region. Perkin-Elmer, eventually, dominated the IR field. They probably had more than 60 percent of the total market. They were very slow in picking up FT-IR. For a long time Perkin-Elmer resisted going into FT-IR instruments so that when they finally arrived, Bloch [Digilap, later Bio-Rad] and [Thermo] Nicolet [owned by Thermo Electron Corporation] had really established a very strong position in FT-IR. I had left Perkin-Elmer at that stage and I could never understand why they didn't move into FT-IR sooner. I think they were so successful selling dispersive instruments that they didn't want to make the effort to switch over and join the rest of the world. They finally did and, I think, today they're number two to Nicolet.

BROCK: We talked about the technical debate between Perkin-Elmer and Beckman on the focal length or the f-number. Why do you think that Beckman was more committed to longer focal lengths than Perkin-Elmer?

WILKS: Well, Beckman didn't know how to make aspheric objects. They did not have the skill in their optical shop. They didn't need it for UV instruments. UV instruments have plenty of energy and could use relatively long focal lengths, so they just didn't have the ability to make an off-axis parabola or an elliptical mirror to focus energy on the detector. That's the reason, basically. Perkin-Elmer was an optical company and Beckman was a laboratory instrument company. They just came from different directions.

BROCK: We talked about the business history dimension of CIC, but we didn't cover that for Wilks Scientific. How did you put together the funding for Wilks Scientific?

WILKS: Well, that was a very fortunate thing. [laughter] When I sell a company, I like to sell it for stock—a stock for stock deal. I took Barnes stock for CIC stock, and shortly after I sold to Barnes, Bowling Barnes came up with thermography, a way of measuring breast cancer by means of temperature. Barnes' skill was remote temperature measurement, using infrared to measure the temperature of transformers. Bowling Barnes came up with the idea of being able to spot malignant tumors by the temperature difference. So he developed this thermograph and it got huge publicity and the Barnes stock went from five to thirty-six dollars in no time. I had sold the company and took what is called "letter stock," which is stock that was not publicly traded and had not been registered by Barnes for public trading.

At that time, I hired a lawyer to take me down to the SEC [Securities Exchange Commission] in Washington and plead hardship—I was starting a company and needed to be able to sell the stock so that I could raise money for the company. I remember that I visited Johnson & Johnson [Consumer Companies, Inc.] in New Jersey and the receptionist called over to me, "You have a telephone call from your home office." I picked up the phone and it was my secretary. She told me, "You've just received a no-action letter which means that the SEC will not take any action against you if you sell the stock." In other words, it meant that my stock was free to sell. The stock that I had traded the company for at five dollars a share was now worth thirty-six dollars. I immediately called my broker and said, "I need money." So I sold a big chunk of the Barnes stock. After that it went back to twelve dollars. [laughter] That was one of the fortunate things that happened to me and gave me the finances to develop Wilks Scientific.

BROCK: Did you keep that company private throughout?

WILKS: Yes. Although, as I mentioned, we did have an investment from EG&G and later from International Nickel. Ultimately, I sold the whole company to Foxboro. Again, that was a stock for stock situation and Foxboro went through a merger, which pushed their stock up, too. That turned out to be a fortunate event.

BROCK: Did you make selective wavelength gas analyzers at Wilks Scientific?

WILKS: Yes. They were all based on filter technology. We used either fixed or variable filters that we could rotate in front of the slit of the instrument to select a particular wavelength. They were not spectrometers of the type that used a grating or a prism.

BROCK: Right, but some of the analyzers were made to look for a specific wavelength.

WILKS: That's right. A characteristic wavelength, and others were more versatile.

BROCK: Those two lines of products had different markets, then?

WILKS: Well, not really. If you wanted an instrument to look at a variety of different potential hazardous vapors in the atmosphere, then you wanted an instrument that allows you to select the wavelength. One time it would be this wavelength, one time it would be another. Often it was the case that you had a specific material and you just wanted to monitor it to make sure that that particular material didn't go above a certain level. That's where you would use a dedicated instrument that had just the right wavelength.

BROCK: Right. Please talk more about the trajectory of GCIR. Most people are more familiar with a different sort of instrumentality that is used as a detector or analyzer for the GC. What was the time period when GCIR was really hot or most used, and what happened?

WILKS: I think it's still very hot, but it was developing in the early 1970s. Almost as soon as GC came over the horizon, it became apparent that there needed to be a method to characterize these various peaks that came off the chromatograph. At CIC we experimented with different kinds of sampling approaches where we could condense a peak onto an aluminum cup and let the gas disappear and the peak deposit. Then we put it in a spectrometer to look at it by reflection.

Later on, at Wilks Scientific, we used ATR as an approach. We built a chamber that you could pass a gas from a chromatograph through. You turned a valve when the peak appeared and that particular peak went through a system where the plates were cooled by a thermoelectric cooler, so that the material you were trying to identify condensed on the surface of the ATR plate. Then we ran a spectrum of that. That was another approach. Finally we developed light pipes that had the same volume as a typical peak would have coming out of a chromatograph—those were actual modifications of the spectrometer itself. We moved the optics back and put the light pipe in between the source optics and the entrance slits. They became a long, thin cell, which was rectangular in shape because the beam in a dispersive instrument is rectangular rather than circular. They were made by electroforming. If you lay down a layer of gold and on top of that lay down nickel, you get a nice tube that is very highly polished inside and has a gold surface. The light pipe approach is still being used today. Also, mass spectroscopy has taken over because it fits very nicely with GC. There's probably more GCMS done today than there is GCIR.

DAEMMRICH: In the early days of the General Analysis Corporation, you had a few years before you went into the direction of the beverage industry. You mentioned that it was probably a product of Reagan's policies that environmental monitoring was unsuccessful.

WILKS: No, it just did not take off. We tried. We advertised and did direct mail, but we never really created any clients. It was a total failure [laughter] as far as we were concerned. So we switched over to try to build our own instrument.

DAEMMRICH: Were there technical difficulties or challenges associated with going from gas to liquid?

WILKS: Well, it's different sample handling. That's the real difference. Everything else about the instrumentation is the same. You're trying to measure infrared absorption at a specific wavelength, but the gas cell has a long path because molecules get dispersed widely, and liquids have to be very short because they clump together and absorb infrared very strongly. So you can't have a long path cell with liquids. That's the advantage of ATR because you have a very short effective path length. Therefore you are in the right absorption range to look at liquids and solids. But the same detectors are used, the same filters are used, and the same dispersive elements are used. We had an interesting situation at GAC because we developed a liquid analyzer.

Again, I received a telephone call from DuPont. They invited me down and said, "We're coming out with a new refrigerant which has turned out to be mildly toxic, so we need to have sensors that we can supply with it. You know something about gas analysis," although GAC was not at all in gas analysis at that time. I looked at our LAN system, which had a three-inch crystal in it.

I remember, I was walking down the fourteenth fairway at our country club one Sunday and it suddenly dawned on me how I could make a gas cell that would have a folded path and fit into the same space that we had to do a liquid analysis. We developed this gas cell, which we patented, and which is a very simple cylinder with flat ends and all gold-plated inside. The beam bounces back and forth and gives a meter path and a three-inch length. We could stick that right in the LAN system. I showed that to DuPont and they said, "Boy, this is great. That's just what we wanted, except it costs about three times as much as we can afford!" So, we totally redesigned the system and came up with a gas analyzer that was used for refrigerant monitoring. It was a very successful instrument for a while until we got some competition from MSA. [laughter]

[END OF TAPE, SIDE 5]

WILKS: With infrared you can handle any kind of a sample, whether it's gas, solid, liquid, film, or whatever. There's always a sampling procedure that will let you look at a sample. The other thing is that infrared is non-destructive. It's not like a chromatograph or mass spec. It doesn't do anything to the sample, so that it works beautifully on a production line. It doesn't upset the sample you're trying to analyze. That's one of the big advantages of infrared. All of my career I've been trying to figure out ways of making cells that could hold the kind of sample that people want to analyze.

DAEMMRICH: How large did GAC get during the course of the 1980s?

WILKS: It got up to about eight million dollars in sales, and then it began to go downhill. [laughter]

DAEMMRICH: About how many employees?

WILKS: About sixty at its peak, as opposed to the two hundred twenty that we had at Wilks Scientific. We have ten at Wilks Enterprise.

DAEMMRICH: What year did you retire?

WILKS: In 1993 I decided that I should turn the company over to someone else.

DAEMMRICH: When you retired in 1993, did you stay on the board of directors?

WILKS: I stayed on the board and began to play around with filter instruments and eventually evolved Wilks Enterprise out of what we were doing.

DAEMMRICH: Sticking with GAC, what kind of board did it have? How was that constituted? Who was on it?

WILKS: There were two former IBM [International Business Machines Corporation] people who invested in the company, and they brought a group from Maersk in Denmark, who also invested in GAC. They were really very excellent outside supporters. I have a high regard for Maersk and their people. It was just unfortunate that through some management mistakes that I made personally, putting the wrong people in, that the company went downhill and we had to end up selling it.

DAEMMRICH: Were you ever in a state of “pure retirement?”

WILKS: For about two weeks! [laughter] I decided I didn’t want to hang around the house. I was still involved to a certain extent in GAC. I own the building that GAC was in, so I took some space out in back and started Wilks Enterprise.

BROCK: What was the effect of competition from other types of instruments on IR in the 1960s, 1970s, and 1980s?

WILKS: For quite a while there wasn't really a lot of competition. Infrared was really the only viable procedure for identifying molecules. In that period, all of these new molecules were being created, like penicillin, for example. By this stage, the absorption bands had been classified so that they could be credited to particular types of chemical bonds. You could take an unknown material that was created by a chemist and determine its structure. That was a big activity in the 1970s as far as infrared is concerned. Then mass spectroscopy and chromatography, which broke mixtures up into components, came along and then NMR [nuclear magnetic resonance], which was a tremendous advance. These other technologies had begun to not so much supplant infrared as to join infrared as qualitative-type instrumentation. In recent years, the use of infrared in laboratories has not grown very rapidly. It grows maybe three percent a year, although, recently, I've seen an increase in the use of infrared, percentage-wise, if you look at the market statistics. I don't quite know the reason for this. Other techniques have come along that are very useful.

The big expansion in infrared today is moving towards process analysis. For the reasons I've given you, it has the features of being able to quantify a mixture. In other words, you can look at a mixture and get absorption bands for each component and quantify them. Secondly, it's not destructive, so that you can stick it into a process stream without upsetting the stream.

The big move in instrumentation today is toward process analysis and process control. There are a lot of methods being used—pH, conductivity, etcetera. Infrared has not gotten into direct-stream analysis as of yet, but it's coming very rapidly and it's going to be very widely used in the next few years because of the reasons that I've mentioned. It's due to better materials, better detectors, microelectronics—all these things have happened that make it more feasible to apply. Mass spectroscopy is a destructive technique. You can't get a mass spectrum without destroying the sample automatically. The same with chromatography. You destroy the sample. UV is non-destructive. NMR is borderline. Raman [spectroscopy] is something that is really coming in now. For years it was a technology that no one had been able to make wide use of, but with lasers that give very intense sources, raman spectra are much easier to come by today. I think that's going to be one of the biggest in-line technologies in the future. It has tremendous possibilities. It's really an infrared technique, but with a different way of getting an infrared spectrum. It creates the same kind of spectrum where you can identify chemical structure and that sort of thing.

BROCK: How important has the development of electronics been to the development of IR technology and to the development of data handling or digital computing?

WILKS: Obviously, it's tremendously important. It's more important with FT-IR type instruments today than it was with the dispersive instruments because computer technology is absolutely essential to make an FT-IR work and once you have a computer you can do a lot of other things. Infrared has grown, from my standpoint, because of programs like the space program. Out of the space program came new detectors, which were immediately usable in commercial-type infrared, and materials—they developed zinc selenide and zinc sulfide crystals. Those were developed as part of the space program or military programs and immediately became applicable to infrared sample handling. As I've said today, microelectronics are absolutely phenomenal in what they can do with tiny chips. That gives you an opportunity to make very small, very useful gadgets that make infrared measurements. Also the cost is coming down tremendously. We can sell these instruments for two or three thousand dollars today, but tomorrow they're going to be two or three hundred dollars. My experience has always been that when the market grows exponentially, prices go down.

BROCK: Do you have any other comments?

WILKS: The only other thing that I can say is that the opportunities in the field of infrared spectroscopy are just as big today as they ever were. A very interesting development has occurred in the last five or six years, which I haven't really touched on. The emergence of near-infrared. As a technology, near-infrared is quite distinct from mid-infrared, and the reason for that is that the absorption bands that you work with are overtone bands. They're not fundamental bands. Every absorption band has overtones at certain frequencies, and in the near-infrared, the overtones from the fundamental bands tend to overlap, so you don't get nice, clean, sharp absorption bands. On the other hand, the energy level in the near-infrared is like a factor of ten or so higher. You have much higher infrared sources. Water is much more transparent in the near-infrared so that you can look through water and see things in water that you can't see in the mid-infrared. There are also materials that are useful, like quartz and glass, which transmit near-infrared and don't transmit mid.

There's been a tremendous development of the near-infrared field in the last few years. To me it's almost like a cult. There's a group that does near-infrared and a group that does mid-infrared, and they don't talk to each other. [laughter] I was invited by a group to join a committee that was trying to develop near-infrared as a qualitative tool. I told them, "This is ridiculous. You can't use near-infrared spectra to identify unknown materials. Stick to mid-infrared."

On the other hand, in a lot of process applications, near-infrared is superior to mid-infrared because it has better transmission and better materials. You ought to stick to what is good. It tickles me because the Eastern Analytical [Symposium] is held every year in New Jersey and I keep being asked, "Why aren't you going to exhibit, Paul?" I tell them, "Well, when you guys have a paper on mid-infrared, I'll exhibit," but every single thing they do is near-infrared. If you sit back and look at it, there are very good reasons for using both parts of the spectrum. You have to look at the job you're trying to do and pick the region where you get the best combination of characteristics.

DAEMMRICH: Reflecting back, you've had a career that spans five companies, yet has been very targeted and focused.

WILKS: That's right. Probably, I've been almost too focused just on one particular technical region, but I always keep saying to myself that there's so much more to be done here. Why should I get involved in mass spec or raman, when there are so many things that I know how to do in the mid-infrared? Therefore I should spend my time there and do not try to go somewhere else. There are a lot of good people that are doing research in other fields.

BROCK: Thank you.

[END OF TAPE, SIDE 6]

[END OF INTERVIEW]

NOTES

1. Paul A. Wilks, Jr., “VPC and IR…a Powerful Team” *Perkin-Elmer Instrument News for Science and Industry* 7, no. 4 (Summer 1956): 4-5.

2. N. J. Harrick, *Internal Reflection Spectroscopy* (New York: Interscience Publishers, 1967).

3. Dan Petersen, *The OSHA Compliance Manual*, *Rev. Ed.* (New York: McGraw Hill, 1979).

4. N. J. Harrick, “Transmission Spectra without Interference Fringes” *Applied Spectroscopy* 31, no. 6 (1977): 548-550.

Index

F

G

H

R

S

T

U